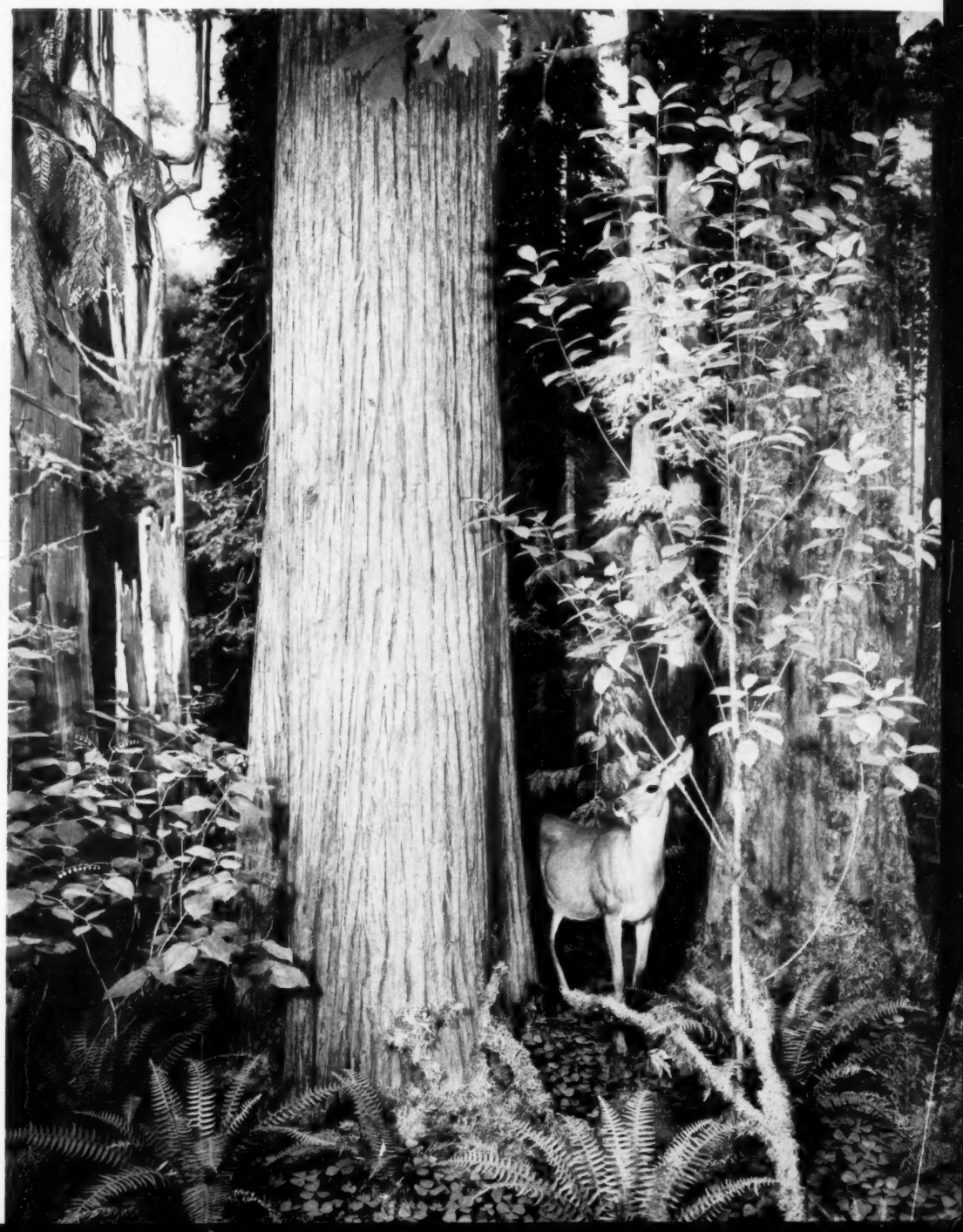
Journal of
FORESTRY

July 1958



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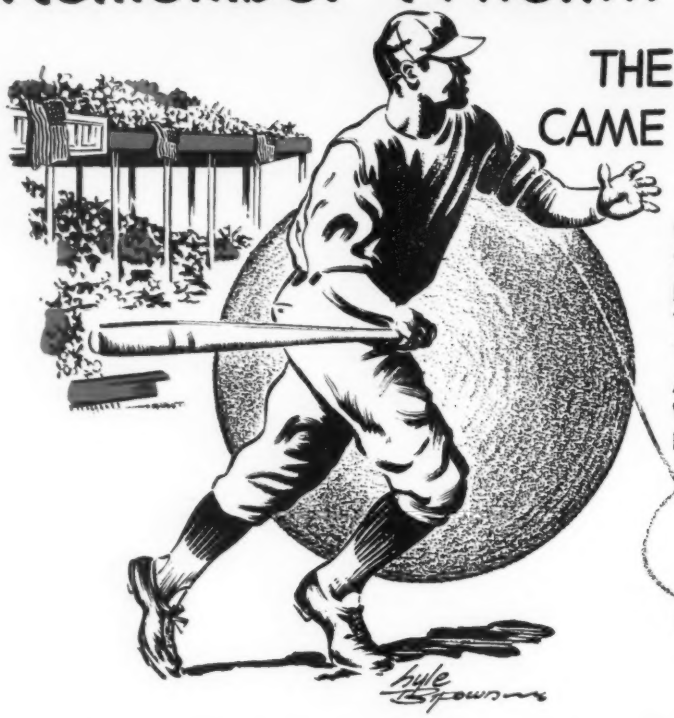

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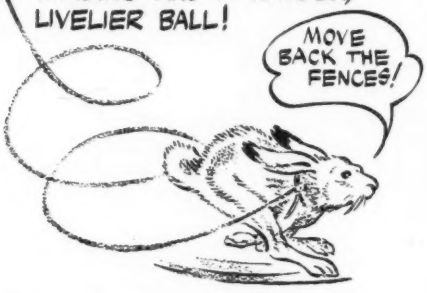

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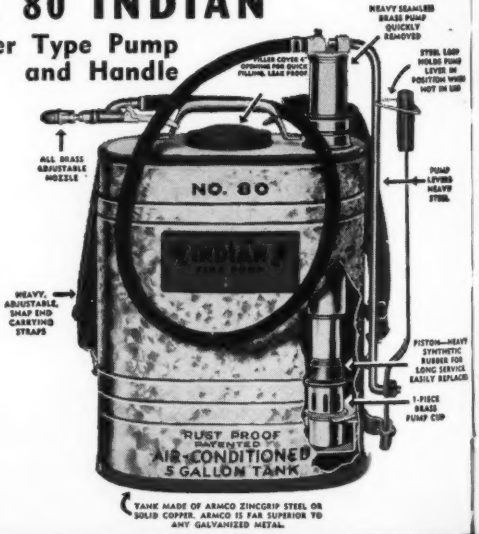
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CONTENTS

COVER: This scene, in the newly opened Hall of North American Forests at The American Museum of Natural History, is a detail of the large habitat group that shows a portion of the Olympic National Forest in Gray Harbor County, Washington.
(Photo courtesy of American Museum of Natural History)

New Hall of North American Forests Opened at Museum of Natural History 467

Growth of Planted Green Ash, Black Walnut, and Other Species in Relation to Observable Soil-Site Characteristics in Southeastern Iowa ..... *Norman J. Hansen* and *A. L. McComb* 473

Cultivating and Fertilizing a Slash Pine Plantation: Effects on Volume and Fusiform Rust ..... *A. R. Gilmore* and *Knox W. Livingston* 481

An Estimate of Capital Needed in Forestry to Meet Projected Timber Requirements for the Year 2000 ..... *Charles H. Stoddard* 484

The Economy of Intensive Management of Forest Lands As It Applies to Site Preparation and Land Regeneration ..... *L. F. Kalmar* 489

Better Yields Through Wider Spacing ..... *J. Harry G. Smith* 492

Water Relations and Growth of Trees ..... *Theodore T. Kozlowski* 498

Aspen Debarking with 2,4,5-T ..... *Cherng-jiann Shiue, R. M. Brown,* and *L. W. Rees* 503

Ambrosia Beetle Infestation of Coniferous Logs on Clearcuttings in Northwestern Oregon ..... *Norman E. Johnson* 508

Notes 512

Growth Increase in Young Redwood Stands After Thinning; Postgraduate Forestry Teaching and Research at Wisconsin; Early Effects of Local Geographic Seed Source on Planted Loblolly Pine; Comments on "The Elusive Formula of Best Fit: A Comprehensive New Machine Program"; The Balsam Woolly Aphid in the Southeast; Diluted 2,4,5-T More Lethal Than Undiluted in East Texas.

Points of View 517

Comments on Stumpage Costs; Lumber Prices and Labor Productivity; Some Questions About the 1957 Forestry School Statistics; Comments on the Discussion of Policy Matters.

Reviews 521

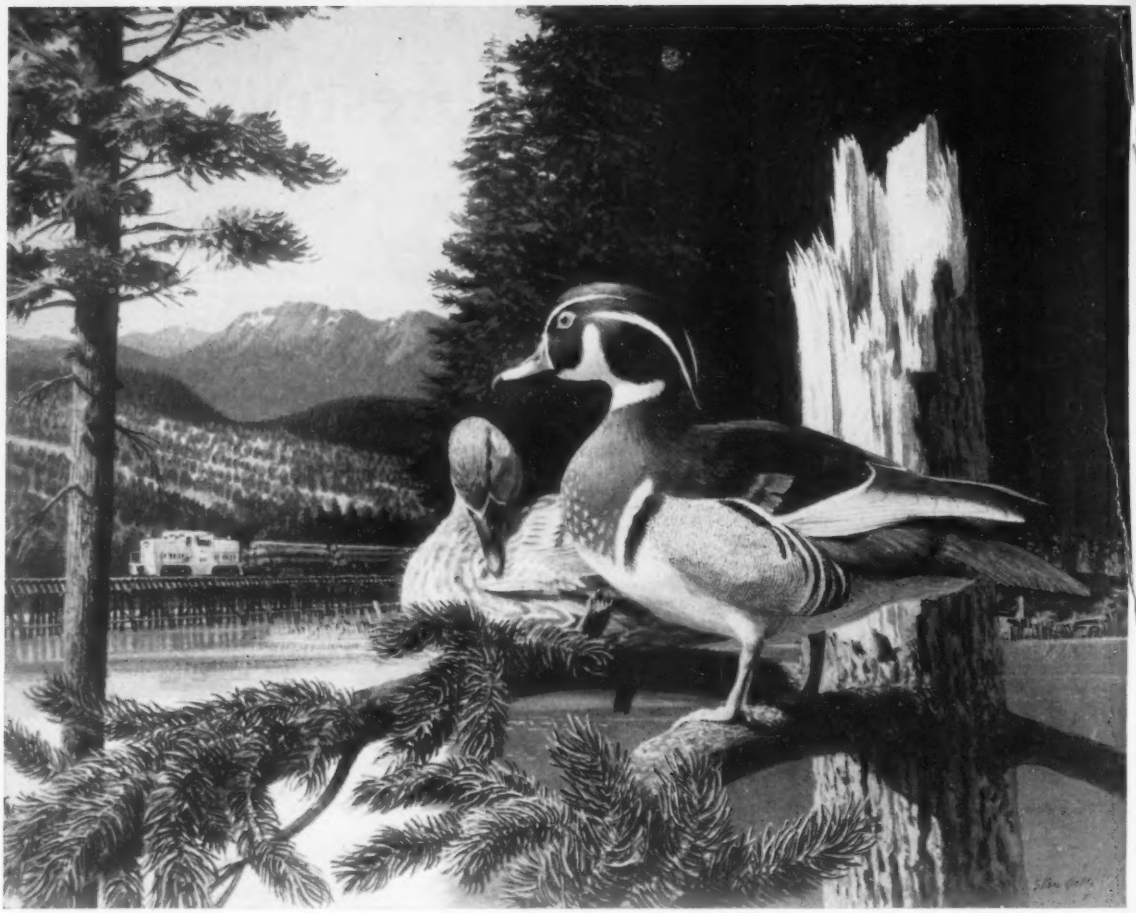
Water Resources; Conservation in America; Forest Soils: Their Properties and Relation to Silviculture; Publications of Interest.

Current Literature 524

Society Affairs 525

Forestry News 536

Index to Advertisers 544



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New Hall of North American Forests Opened at Museum of Natural History

THE HALL OF NORTH AMERICAN FORESTS, a sweeping panorama of the forests of this continent, and a vivid interpretation of their relation to man, was opened to the public on May 14 at The American Museum of Natural History, New York City.

This dynamic presentation of the forest as a biotic community ranges in its scope from the towering redwoods of the Pacific Coast to the minute plants and animals that inhabit the floor of an eastern woodland. It is the most comprehensive exhibit of its kind in the world.

On May 13, 250 representatives of science, education, forestry, and industry joined the Museum officials in ceremonies marking the completion of the Hall, which was ten years in the making. Speaking at this event, Richard E. McArdle, chief of the U.S. Forest Service, voiced the need for widespread public understanding of man's dependence on the forests, and emphasized the significance of the new Hall in bringing about such understanding.

John H. Hinman, chairman of the Board of Directors of International Paper Company, told the audience that the future of his company, a major forest management organization and a substantial producer of a wide range of forest products, "is based on the fundamental notion that the forests of North America, properly managed and protected and harvested, can provide an endless source of supply of wood." His company was one of the donors of the exhibit.

Other speakers were Alexander M. White, Museum president, who welcomed the guests; Albert E. Parr, Museum director; and Jack McCormick, ecologist in charge of the new Hall.

In order to show the diversity of forest communities in North America and their distribution, the Museum has reproduced actual forest sites from Canada, New Hampshire, New York, Tennessee, South Carolina, Missouri, Arizona, Colorado, Montana, California, and Washington. Included are forests of Catskill sugar maples, New England birches, southeastern swamp cypress, mixed hardwoods in the Ozark and Great Smoky Mountains, northern spruce and fir, southwestern cactus, western pine and juniper, timberline growth in the northern Rockies, Coast redwood, and Olympic Peninsula rain forest conifers.

Each of these 12 life-sized, three-dimensional exhibits, startling in its illusion of reality, has been created with the artistic excellence and meticulous attention to scientific detail for which the Museum's habitat groups are famous. Each depicts a forest setting in which not only trees and smaller plants, but also mammals, birds, reptiles, amphibians, and even tiny insects form an integrated community.

The Hall's largest single exhibit is the Washington State rain forest group, with its huge Douglas-firs, sitka spruces, and Pacific sil-

A STAFF ARTIST completes the background mural for the Jeffrey pine exhibit. The smaller painting from which the artist is working was painted "on location" in the Indiana Summit area of Mono County, California.

DURING the 1870's the maple sugar industry was at its height in the Catskill Mountains of New York State. Here a scene in Black Dome Valley, Greene County, is the setting for one of the three-dimensional exhibits.

DR. ALBERT E. PARR, director of the Museum, calls the attention of a young visitor to the wonders of the exhibit, which here shows a scene in a mixed hardwood forest indigenous to the Great Smoky Mountains, near Gatlinburg, Tennessee.

ONE of the Museum preparators brushes a warbler's feathers into place as the Southeastern Coastal Plain exhibit is completed. Eleven other life-sized groups show forest sites across the country and many specialized displays demonstrate man's use of the forests in the most comprehensive exhibit of its kind in the world.

SOUND TECHNICIANS install the equipment for the Guide-a-Phone lectures. Guide-a-Phones are portable listening devices through which Museum visitors can hear recorded lectures explaining the various exhibits. The exhibit shown here demonstrates what a small portion of the forest floor would look like if enlarged 24 times.

WORKING from sketches and photographs to insure absolute authenticity, a preparator reconstructs a tree for the Jeffrey pine forest exhibit, a scene in Inyo National Forest, Mono County, California.

ver firs reaching upward and out of sight. Here, the black-tailed deer peers from the undergrowth, the sooty grouse forages in the luxuriant ground cover, and a profusion of smaller fauna engage in their usual pursuits in this rainiest region of the United States.

In striking contrast, the giant cactus forest group shows the sun-drenched landscape of the Southwest when the desert is in bloom, and the myriad forms of animal life that manage to survive in these parched regions.

An effect of man's presence in the forest is shown in the Southeastern Coastal Plain group, where a couple of wild turkeys retreat warily behind the dwarf palmetto as a boatman approaches through a swamp grown thick with bald cypress, blackgum, and magnolia.

Speaking at the preview, Dr. Parr explained that the new Hall was the second in a projected series of halls designed to present nature as the environment of man, and to explain man's relationship and responsibilities to nature. The first of the series is the Warburg Memorial Hall of Nature Near New York, which opened in 1951. The third in the series will be the proposed Hall of General Botany, and the fourth will be the Hall of Insects and Insect Life.

Dr. McCormick discussed the concept of the forest as an integrated community, and likened it to a city with its many residents, its variety of dwelling places, its division of responsibilities, its manifold activities. And like a city, he said, all the organisms of the forest—from microscopic bacteria to massive trees — are integrated into a composite whole.

In addition to the habitat groups, the Hall includes exciting specialized exhibits designed to dramatize the relation of man to the forest, and of the organisms of the forest to one another.

The incredibly realistic leaves on the trees and shrubs are made of paper and wax, plastic or acetate. But the branches or shrubs to which they are attached are real, soaked for a month in a mixture of glycerin, formalin, and water to kill bacteria and insects. Needles from coniferous trees are treated the same way, and are then affixed to the branches with a latex preparation.

In a unique exhibit, the tiny creatures that inhabit the forest floor come to life with dramatic impact through the use of an enlargement 24 times natural size. Here a 12-foot white oak leaf supports a five-and-a-half-foot millipede and a daddy-long-legs three feet high, while other specimens, also enlarged to scale, cluster together in a demonstration of the almost unbelievable density of life that exists in a small section of forest soil.

Another special exhibit shows the records of drought and deluge found in a 4,500-year-old bristlecone pine stump. This is the oldest authentically dated tree in the world, and originally grew in the White Mountains of eastern California.

Also on display is a cross-section of the giant sequoia known as the Mark Twain Tree, which was cut in 1891 at the age of 1,341 years. The cross-section on exhibit is 16 feet, 5 inches in diameter inside the bark.

The effects of forest fires and windstorms are illustrated dramatically in mechanized displays. Damage wrought by forest diseases, fire, insects, and larger animals, as well as methods of protection devised by man, are depicted through the use of models. The many ways in which forests serve man, the principles on which foresters have based various methods of timber harvest, and the manifold uses of wood are portrayed in still other exhibits.

In his welcoming speech, Mr. White expressed appreciation to the donors, whose generosity has made the Hall possible. They are Mr. Childs Frick, Mr. Clarence L. Hay, Mr. H. Nelson Slater, Mr. and Mrs. Robert D. Sterling, the late Mr. Beverly R. Robinson, and the International Paper Company and the Great Northern Paper Company.

Over 100,000 man hours and nearly $500,000 have been spent on the new Hall. Creation of the exhibits required the combined knowledge and skills of Museum scientists, designers, artists, and technicians. In addition, well over 200 people outside the Museum contributed materials or information for the Hall. These include members of the U.S. Forest Service, the National Park Service, and numerous staff members of universities.

The Habitat Groups

Northern Spruce-Fir Forest Group

The great northern evergreen forest is virtually continuous from the Atlantic to the Pacific, across the northern portion of the continent. This exhibit was collected in Ontario, Canada, about 150 miles north of the United States border, in mid-August of 1954. The scene is on the shore of Lake Nipigon, near the town of Macdiarmid. In the distance are cliffs on top of which grow forests of white spruce and balsam fir. Where the land has been burned over, quaking aspen and paper birch quickly establish themselves. In the foreground, a swamp forest of black spruce is developing at the head of a sheltered cove of the lake. Many shrubs and plants of the upland forests are vividly shown.

Early October in Southern New Hampshire

Sunapee Lake lies in Merrimack County, southern New Hampshire, about 15 miles from the Vermont border. The woodlands of Sunset Hill, shown in this group, are on the shores of the lake and are a part of the northern hardwood forest. Beech, sugar maple, and hemlock are the most characteristic species in this type. But several additional species are normally present and vary in abundance according to soil conditions, lumbering, or natural disturbance such as windstorms or fire. At Sunapee Lake, for instance, the red pine and paper birch became abundant after a severe wind

storm which uprooted many trees, thereby providing a bare mineral soil and sufficient light for them to become established.

Making Maple Sugar in the Catskills

The making of sirup and sugar from the sap of the sugar maple was learned from the Indians. By 1870, the peak of the sugar industry, "sugaring off" had almost become a spring ritual. This group, collected in March 1948 in the Black Dome Valley south of Maplecrest, Greene County, New York, represents a scene in the 1870's and shows one way in which humans have modified the forest. The maple sap trickled into gathering pails, which were collected and hung on sap yokes carried across the shoulders. The pails were then taken to a lean-to where the sap was boiled over an open fire fed with the wood of the unwanted trees cut from around the maples. In this way, beech, birch, hemlock and other species were gradually eliminated from the forest.

Mixed Hardwood Forest Group

The mixed hardwood forest group depicts an area near Gatlinburg, Tennessee, in the Great Smoky Mountains National Park, at an elevation of 3,500 feet. These forests occupy a large portion of the mountainous parts of the southeastern United States. In the moist coves of the Great Smokies, the community reaches its maximum development. As many as 30 species may contribute to the leafy canopy of the forest. This exhibit contains twelve species of trees, collected in May of 1952. Outstanding among these are the giant tulip-poplar, the sweet buckeye, and the silverbell tree

Oak-Hickory Forest Group

The Current River runs through south central Missouri. Here, near Eminence, in Shannon County, at an altitude of about 800 feet, this group was collected in 1954. It shows, in particular, the development of layers of vegetation, one of the most striking aspects of the forest. This layering represents one of nature's economies, allowing as much as 10 acres of leaf surface to be exposed over a single acre of land. The overstory, or taller tree layer, is made up of white oak, northern red oak, and mockernut hickory. The understory is composed mostly of dogwood trees, liberally intersprinkled with sassafras. Collected in mid-August, this group shows the first signs of autumn in the reddening of the blackgum and flowering dogwood.

Southeastern Coastal Plain Forest Group

In the southern tip of South Carolina, near the Georgia border, swamp forests of bald cypress occupy the quiet, shallow waters along the Coosawhatchie River. In these historic lowlands, the live oak, festooned with Spanish moss, and the dwarf palmetto present the same picture today as greeted the Spanish and English settlers in the 1600's. In the less frequently flooded areas, nearer the river banks, the swamp forest is composed of blackgum, red bay, and the southern magnolia. With a small rise in the ground level, where the surface is elevated a foot or more above the water table, the transition to pine flatwoods is very sharp. This kind of swampy area supports the cane-brake rattler. This group was collected near the town of Coosawatchie in Jasper County in mid-March of 1951.

Giant Cactus Forest Group

In the arid regions of southwestern United States many plants have become adapted to meager rainfall. The giant cactus, or saguaro, stores a supply of water during the wet season, actually swelling during the process, and shrinking during dry periods. The widely spaced saguaros, which have well-developed woody frames, form a sparse forest — a community peculiar to the Sonoran Desert. The group was collected in the Saguaro National Monument, about ten miles east of Tucson, Arizona, during mid-April of 1953, just after the spring rains. The altitude here is 3,100 feet.

Pinon-Juniper Forest Group

In western United States, between the grassy or shrubby lowlands and the more luxurious coniferous forests of higher elevations, the piñon-juniper forests cover 74 million acres. It is one of the most wide-spread and variable of the western forest types. The forest shown here is composed of the piñon pine and the Utah juniper. Two kinds of piñon-juniper forest growth are shown—the "high forest," which grows on heavier soils, and the "low forest," which is smaller, bushier, and more widely spaced on coarse, drought-parched soil. This group was collected in early October, 1956, in Colorado National Monument, near Grand Junction.

Jeffrey Pine Forest Group

Inyo National Forest is in east central California near the Nevada border. Here the Jeffrey pine forms a pure forest in the Indiana Summit area, a few miles east of the Sierra Nevada, at an altitude of about 8,500 feet. This group was collected in 1954 in Mono County, near the town of Crestview, in early June. In the past, numerous fires swept through this area, leaving many trees scarred and blackened. Far in the background is Mount Morrison, the highest visible peak, 12,245 feet high. Long Valley, in the lower foreground is covered with sagebrush.

Coast Redwood Forest Group

From southwestern Oregon to the Santa Lucia Mountains south of Monterey, California, the coast redwood forest stretches almost continuously for 450 miles. This forest occurs primarily at altitudes below 1,000 feet in the mountains which front upon the Pacific Ocean. The climate is mild and rainfall is abundant. The group, collected in mid-summer of 1954, and here presented in semi-miniature, shows a portion of the Bull Creek Flat Grove in the Humboldt Redwood State Park, near Dyerville, about thirty miles from the Pacific.

Timberline in the Northern Rockies Group

In the high mountains and in far northern regions, conditions are not favorable to tree growth. Short growing seasons, low temperatures, and strong winds are among the factors that limit forest growth. This group, collected in mid-July of 1952, depicts an area near Logan Pass in Glacier National Park, Montana, where patches of snow still cling to the mountains. Representing an elevation of 6,664 feet, it shows a typical summer-time view at timberline. Here, the stunted and gnarled whitebark pines, Englemann spruce and subalpine fir are the last vestiges of the extensive coniferous forests found at lower elevations. Higher up, the small groups of trees that do occur can survive only in the protection of a boulder or rock ledge.

Olympic Rain Forest Group

The Olympic Peninsula of the State of Washington is bounded by the Pacific Ocean on the west and by the Strait of Juan de Fuca, through which runs the Canadian boundary line, on the north. At Quinault Lake in the Olympic National Forest, the site of this group, the average annual precipitation is 129 inches. (Mount Olympus, 7,915 feet high, visible in the background, is estimated to have 250 feet of snow each year.) Here, in the rainiest area of the United States, are found dense forests of Douglas-fir, western hemlock, Pacific silver fir, big leaf maple, and other species. This group, collected in 1951, is illustrated on the cover of this issue.

Specialized Exihibits

The exhibition techniques used in the construction of the Hall of North American Forests took elements from nature and life, coupled these elements with the theories, concepts, and philosophies of scientific research, and combined them into meaningful presentations which tell a story. This story must be readily understandable to all levels of comprehension—from the child to the adult, from the city dweller to the country man, from the completely uninformed to the experienced in nature.

THIS MAP, 15 feet long and 11 feet high, shows all of the major vegetation areas of this continent. Dr. Jack McCormick, ecologist in charge of the Hall, and John Andresen of Rutgers University, consultant in forestry, discuss the labeling of the map, which is a bas-relief in brightly colored plastics.

The specialized exhibits are designed to explain in detail the relationship of man to the forest. They do so by the use of murals, dioramas, mechanized displays, maps and models.

Forest Food Web

This striking exhibit shows the relationships among the plants, insects, birds, and other animals of the forest in their never-ending search for food. Ultra-violet light thrown on the mural intensifies the color dramatically. In the foreground of this exhibit, life-sized three-dimensional models and mounted specimens help demonstrate the relationships. A Luna moth caterpillar eats a green leaf of a beech tree seedling. A shrew eats the caterpillar. An owl eats the shrew. The owl, in turn, dies and the chemicals in its body are returned to the soil from which the tree grows, completing the cycle.

Stories a Stump Can Tell

Cross-sections of various kinds of trees demonstrate the ways in which tree-rings bear evidence of fire, landslides, windstorms, disease, fast or slow growth, and age. One such cross-section is from the oldest authentically dated tree in the world — a 4,500-year-old bristle-cone pine, whose seed germinated in the White Mountains of California about 2,550 B.C. The cross-sections in this exhibit have been highly polished in order to show the rings more clearly, and have been protected from dampness and cracking.

The Big Tree (or Giant Sequoia) Log

This section of the massive sequoia known as the "Mark Twain Tree," was felled in California in 1891. It was 331 feet tall, 90 feet in circumference at the base, and was free of limbs for 200 feet from the ground. This section is 16 feet 5 inches in diameter inside the bark, and, after years of seasoning, weighs 9 tons. It shows 1342 annual rings. A sequoia seed, shown in an exhibit beside the lot, weighs less than one three-thousandth of an ounce. The tree that develops from such a seed may eventually weigh 65 billion times as much.

The Forest: River Bottom to Hilltop

A beautiful mural, executed by a Museum artist, shows the way in which forest communities are influenced by soil moisture, depth, composition, and elevation. This is done by showing the profile of a section of land, from river bottom to hilltop, with many of the varieties of trees that grow in each location. The trees range from river birches, thriving on the unstable, flooded river sandbar, to chestnut oaks and pitch pines that live on top of the hill, where erosion is extensive, winds are strong, and moisture is at a minimum.

Vegetation Map

On a panel 15 feet long and 11 feet high has been superimposed a plastic relief map of North America. This brilliantly colored map shows the major vegetation areas of this continent, keyed by both color and number so they may be located at a glance.

Weather Mural

The first section of this three-part mural shows a forest on a sunny afternoon in July. The second section shows the same scene a few minutes before sunrise on the following morning. The third section shows a thunderstorm that afternoon. The mural is designed to demonstrate the ways in which the forest modifies light, humidity, temperature, wind, rain and evaporation during a 24-hour period.

Life on the Forest Floor

The density of life on a small portion on the forest floor springs into three-dimensional realism in this exhibit by an enlargement of 24 times. A 12-foot white oak leaf supports a five-and-a-half-foot millipede. A three-foot daddy-longlegs also perches on the leaf, beside which is a two-foot acorn.

Forest Soils

This exhibit shows the above-and-below ground characteristic of trees growing in three different types of soil. Different kinds of root structures are displayed in relation to their soil environment, and the interdependency of the soil and the trees is explained.

How the Forests Serve Man

Here a miniature diorama shows how forests contribute to man's life and well-being. The forests, as the exhibit demonstrates, provide man with wood for construction and fuel, conserve water for his use, protect his soil from erosion, give him recreation in camping sites, hunting areas, and fishing streams.

Forest Protection

This display is divided into three sections showing ways in which the forest can be protected from insects and disease, larger animals, and fire. The first section, dramatized by small impressionistic figures of cows, sheep, deer, rodents, demonstrates the damage wrought by these creatures, and points out that the regulated hunting of the larger wild animals, such as deer, is an essential in forest management. The second section, devoted to forest protection from insects and disease, also uses miniatures in showing how to control insects by chemicals, by proper methods of cutting, and by the establishment of quarantines in infected areas. In the third section, which describes protection from fire, models show some of the ways in which fires are started.

Forest Insects

In this remarkable exhibit are exposed the activities of eight of the forest's most pernicious insect pests — birch leaf miner, spruce budworm, cicada, locust bore, southern pine bark beetle, spongy oak apple gall, white pine weevil, and acorn pine weevil. A rotating drum in the foreground displays the life cycles of these insects and a label tells at what period in their lives—as larvae, pupae, or adults—they do their worst damage. In the background are models of each insect, greatly enlarged.

How Nature Harvests the Forest

Three of nature's methods of harvesting her forests — by fire, wind, and insects—are shown as a never-ending process, which determines in large measure the character of certain forest areas. To demonstrate the fire-harvesting method, a scene in the northern Rockies is used, showing a burned-over spruce-fir forest. Cones from occasional pine trees have survived, and release seeds that give rise to a pure pine forest. Spruce and fir seedlings then develop in the shade of the pines, and eventually crowd them out. Once more a spruce-fir forest is established.

Forest Diseases

This exhibit describes infectious and noninfectious tree diseases. The infectious diseases, including virus, fungus, and flowering-plant diseases, can alter a whole forest by attacking only one or a few species of trees. The noninfectious diseases act only on trees with similar environmental requirements, and may result from adverse climatic or soil conditions. They have a vast economic importance, for they can alter the rate of tree growth or damage the wood seriously. It is estimated that tree diseases kill more than one-fifth of each year's growth of wood.

How Man Harvests the Forest

Three varieties of proper cutting methods are shown through the use of stylized tree models. First is the clearcutting method, used for those trees that need a great deal of sun. Second is the seed-tree method of harvesting. Third is the selection method in which mature trees, those that are poorly formed, overcrowded, or diseased are harvested.

How We Use Our Wood

This animated exhibit consists of five panels that present a breakdown of the various ways in which man uses wood products. When the panels are closed, they form a large photo mural of log drivers riding logs down a river. Then the mural divides into five sections that turn one at time and show on their reverse the end products of timber. The relative importance of each product to the national economy is dramatized by piles of coins on each panel.

Growth of Planted Green Ash, Black Walnut, and Other Species in Relation to Observable Soil-Site Characteristics in Southeastern Iowa[1]

Norman J. Hansen and A. L. McComb

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REFORESTATION AIMED at the production of wood crops and watershed protection has been suggested as a means to better utilization of depleted, submarginal farmland in Iowa. Before accepting the premise that tree crops constitute the highest use of such lands, it must be determined whether the growth of economically desirable species is feasible in the region and on the soil-sites designated for planting.

During the depression and drought of the decade 1930-1940 the State of Iowa purchased submarginal farm land for state forests in southern Iowa. The eroded old fields of these marginal farms had been carved originally from the oak-hickory forests that covered the hilly topography in the Weller-Lindley soil association area. These gray-brown podzolic and planosol soils are old, highly-weathered loess and till, acid, base deficient, and most possess a tight claypan at 12 to 24 inches. Average annual precipitation for the area is about 34 inches. The site index for white oak ranges from 45 to 55.

Shortly after acquisition of these lands a reforestation program was started. Since no one knew which tree species might prove adapted, the planting from 1937 through 1941 was done on an experimental basis using many kinds of native and introduced coniferous and broadleaf species.

After the plantations had grown for 12 to 15 years marked differences in growth on various sites were observed. For example, green ash (*Fraxinus pennsylvanica* Marsh.), the broadleaf most frequently planted on upland sites survived very well, but growth was adequate on less than 10 percent of the area planted. Furthermore, black walnut (*Juglans nigra* L.), most frequently planted on bottomland and cove sites, was growing satisfactorily on less than five percent of the planted area. Many other native broadleaf species also grew poorly. Observational evidence suggested that reforestation with native broadleaf species was not practical on the majority of the old-field sites in southern Iowa. In contrast, many of the pines were growing satisfactorily, had developed through the Christmas tree into the post and small pole stage, and promised to yield additional wood crops on this depleted farm land.

It was evident from field observation that a study of the soil-site relations for the different species would yield information of great value in future planting programs. Therefore, a survey of the plantations in southern Iowa was made to evaluate survival and growth. This paper presents some of the survey findings pertaining to species-site evaluation.[2]

Procedure

Sample plots, usually containing a minimum of 30 planted trees were established on as many different sites as possible. Each plot was representative of one soil type-aspect combination. Aspects were classified as north and east (90° right and left of N 45°E), south and west (90° right and left of S 45°W), or none on lands with slopes less than 3 percent. Plots were located at random when the size of a given species — soil type — aspect combination exceeded the size of the plot.

Soil profile data included the thickness, color, texture, structure, and mottling by horizons. Other site characters recorded were per-

[1]Journal Paper No. J-3317 of the Iowa Agricultural and Home Economics Experiment Station, Ames, Iowa. Project No. 1154. (In cooperation with Iowa State Conservation Commission.)

[2]For additional information see:

a. Hansen, Norman J. Forest plantations in relation to sites in southeastern Iowa. M. S. Thesis, Library, Iowa State College, Ames, Iowa. 246 pp. 1954.

b. Hansen, Norman J., and A. L. McComb. Growth, form and survival of plantation-grown broadleaf, and coniferous trees in southeastern Iowa. Proc. Iowa Academy Sci. 62:109-124. 1955.

TABLE 1.—MEAN, MAXIMUM, AND MINIMUM ANNUAL HEIGHT AND DIAMETER GROWTH OF PINES AND BROADLEAVES PLANTED ON OLD-FIELD SITES

Species	No. plots	Ann. ht. growth—feet Mean	S.D.[1]	Max.	Min.	Ann. dia. growth—inches Mean	S.D.	Max.	Min.
				(Conifers)					
Pinus banksiana Lamb.	18	1.79	.11	1.95	1.60	.288	.023	.299	.260
Pinus resinosa Ait.	11	1.60	.07	1.72	1.50	.318	.022	.365	.289
Pinus ponderosa Laws.	10	1.14	.06	1.21	1.05	.228	.020	.254	.179
Pinus strobus L.	5	1.48	.16	1.68	1.30	.244	.033	.290	.204
Pinus echinata Mill.	3	1.77	.34	2.09	1.41	.356	.029	.389	.333
Pinus virginiana Mill.	3	1.86	.19	1.97	1.64	.341	.045	.393	.316
				(Broadleaves)					
Juglans nigra L.	38	1.08	.68	2.62	.17	.143	.108	.415	0[2]
Fraxinus pennsylvanica Marsh.	36	1.43	.72	2.56	.16	.156	.092	.314	0[2]
Quercus rubra L.	14	1.24	.44	2.02	.48	.159	.065	.243	.032
Ulmus americana L.	9	1.34	.56	2.12	.44	.174	.090	.295	.022
Robinia pseudoacacia L.	6	2.47	.35	2.83	1.96	.311	.033	.347	.264
Quercus macrocarpa Michx.	6	.98	.53	1.67	.28	.141	.096	.255	0[2]
Acer saccharum Marsh.	5	.73	.47	1.52	.33	.063	.051	.195	0[2]
Maclura pomifera (Raf.) Schneid.	4	1.33	.45	1.80	.75	.144	.070	.226	.057

[1]Standard deviation among plot means.

[2]Trees have not reached breast height in 12 to 15 years.

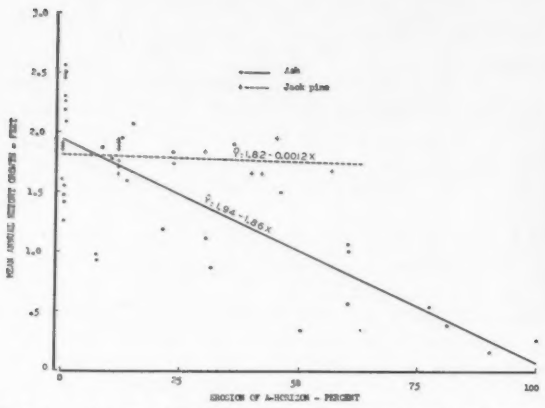

FIG. 1.—Relation of height growth of green ash and jack pine, 12 to 15 years after planting, to erosion of A-horizon.

FIG. 2.—Vigorous jack pine in background planted on an old field at the same time as slow growing green ash and hard maple in foreground.

cent slope, position on slope, aspect, and degree of erosion. An estimate of the amount of erosion was made by dividing the thickness of the soil zone above the impermeable B_2 horizon by the average thickness of a similar undisturbed soil type. This method is only approximate, because the thickness of the surface soil varies with topographic features.

Since the trees in the plantations usually ranged from 12 to 15 years in age, mean annual height growth was used as the criterion of site quality. Tree height was measured with a sectional cane pole to the nearest one foot for trees taller than 20 feet and the nearest one-half foot for trees less than 20 feet tall. The sum of all tree heights per plot was divided by the number of trees measured to obtain the average stand height, which was divided by the years since planting to obtain the mean annual height growth. Stem diameter was measured with a tree caliper, and the mean annual diameter growth was calculated as above.

Results

The data in Table 1 enable a comparison of the different pine and broadleaf species on the basis of mean annual height and diameter growth. The growth variation among pines up to 15 years after planting was slight and apparently not strongly correlated with soil type, degree of erosion, thickness of rooting zone, position on slope, or aspect. Pines, however, were not planted on as wide a range of sites as some of the broadleaf species; the better cove and bottomland

FIG. 3.—Differential response of green ash to site. *Left,* 12-year-old plantation on eroded old field. *Right,* 14-year-old plantation on lower slope of virgin prairie. Shorter tree with leaves is red oak of same age.

sites were planted to broadleaves, and black locust was usually planted on the most severely eroded spots.

Broadleaf species, other than black locust, proved very sensitive to site variations related to cultivation, grazing, and erosion. Maximum growth of broadleaves occurred on uncropped and ungrazed sites. On previously uncropped but heavily grazed land growth was decidedly less and on heavily cropped and eroded areas growth was extremely small. Figure 1 shows the highly significant effect of erosion on ash and the non-significant effect on jack pine. Figure 2 illustrates this difference. It is probable that with increasing age pine growth will be affected more adversely by erosion because of the reduced moisture storage capacity of the shallower rooting zones.

Ash.—Thirty-six plots of green ash growing on upland sites were measured and described. Regardless of site ash survived very well; the average mortality within plantations 12 to 15 years after planting was 12± 10 percent. However, great differences in height and diameter growth (Fig. 3) were associated with site factor variation.

The mean annual height and diameter growth among plots ranged from 2.6 to 0.2 feet and 0.31 to zero inches (for plots where trees were less than 4.5 feet tall), respectively. Differences in height growth were attributed principally to site differences while diameter growth was affected by both site quality and tree spacing. On good sites diameter increment was limited by the available crown and root space.

Diameter and height increment of ash decreased as the degree of soil erosion increased. In the case of no erosion two different populations were evident, probably the result of past land treatment. The group of plots falling above the regression line in Figure 1 represented the uncultivated-uneroded sites, and those below were the cultivated-uneroded sites. Many of these cultivated-uneroded sites occurred in the upland drainage basins and were colluvial complexes with recent deposition from the eroded hillsides.

Apparently, cultivation had a deteriorating effect on soil quality for ash even when erosion was not involved. To check the possibility of differences in nitrogen nutrition, leaflet samples were collected on August 26 and 27, 1953 from the south side of the crowns of dominant trees in 13 ash plots on uncultivated and cultivated sites. The samples were air-dried, ground in a Wiley Mill, oven-dried at 100°C and analyzed for total nitrogen content by the Kjeldahl method. The direct correlation between mean annual height growth and percent of leaf nitrogen was highly significant (Fig. 4). Fast tree growth and high leaf nitrogen content were closely associated with the uncultivated-uneroded sites (Table 2) whereas the volume weight (bulk density) of the surface soil was not. This suggests

TABLE 2.—PERCENT NITROGEN IN OVEN-DRIED LEAFLET SAMPLES OF ASH IN RELATION TO AVERAGE ANNUAL HEIGHT GROWTH AND CERTAIN SITE FACTORS

Plot no.	Percent nitrogen in ash leaflets[1]	Aver. ann. hgt. growth (feet)	Former land use[2]	Percent erosion A-horizon	Percent slope	Position on slope[3]	Vol. wgt. surface soil[4]	Soil type[5]
97	2.26	2.07	Uncult.	0	2	U ⅓	1.24	M. si. lm.
59	2.24	2.29	Uncult.	0	13	M ⅓	1.13	W. si. lm.
158	2.23	2.51	Uncult.	0	12	L ⅓	1.13	S. si. lm.
31	2.22	2.47	Uncult.	0	3	Cove	1.40	O-W. si. lm
23	1.95	2.19	Uncult.	0	9	L ⅓	1.23	W. si. lm.
71	1.93	0.91	Cult.	7	16	M ⅓	1.33	W. si. lm.
73	1.88	1.56	Cult.	0	7	Cove	1.37	O-W. si. lm.
24	1.86	1.52	Cult.	46	12	M ⅓	1.43	W. si. lm.
76	1.80	1.47	Cult.	0	0	L ⅓	1.45	O-W. si. lm.
61	1.79	2.45	Uncult.	0	10	Cove	1.43	O-W. si. lm.
12	1.76	1.95	Cult.	12	3	U ⅓	1.40	W. si. lm.
68	1.67	0.84	Cult.	0	0	U ⅓	1.27	M. si. lm.
13	1.44	0.26	Cult.	100	15	U ⅓	——	W. si. lm.

[1]Kjeldahl analysis.
[2]Cultivated or uncultivated.
[3]Upper ⅓, middle ⅓, and lower ⅓ of slope.
[4]Volume weight was average of three cores (256.50 cubic cm. core) per plot.
[5]Marion silt loam, Weller silt loam, Shelby silt loam, and Olmitz-Wabash silt loam.

TABLE 3.—MEAN ANNUAL HEIGHT GROWTH (FEET) OF ASH BY PAST LAND USE[1], SOIL EROSION AND DEPTH,[2] AND MICRO-CLIMATE

Soil erosion and depth	Past land use a_1	Past land use a_2	Past land use a_3	Average growth by soil quality class
b_1	2.50/4[4]	2.19/1	1.42/4	1.99/9
b_2	2.21/3	1.80/6	1.10/6	1.60/15
b_3	——	1.54/3	.57/9	.81/12
Average growth by land use class	2.37/7	1.76/10	.92/19	1.43/36

Micro-climate	Past land use a_1	Past land use a_2	Past land use a_3	Average growth by micro-climate class
c_1	2.54/2	1.54/3	1.10/5	1.53/10
c_2	2.31/5	1.84/7	.85/14	1.40/26

	Soil erosion and depth		
Micro-climate	b_1	b_2	b_3
c_1	2.17/4	1.44/2	.94/4
c_2	1.84/5	1.63/13	.75/8

[1] (a_1) Uncultivated-ungrazed-uneroded
(a_2) Pastured intensively
(a_3) Cultivated and cropped without maintenance of soil fertility.
[2] (b_1) No erosion of A-horizon and rooting zone 24 inches or more in thickness.
(b_2) Zero to 50 percent erosion of A-horizon and rooting zone 13 to 24 inches thick.
(b_3) 51 to 100 percent erosion of A-horizon and rooting zone zero to 12 inches thick.
[3] (c_1) Cool, moist, and protected on northern and eastern aspects and lower slopes.
(c_2) Hot, dry, and exposed on upland flats, rounded ridge tops and southern aspects.
[4] Number of plots on which mean annual height growth is based.

TABLE 4.—NUMERICAL SITE QUALITY GROWTH INDEX VALUES ASSIGNED TO ENVIRONMENTAL FACTORS RELATED TO THE GROWTH OF ASH

	Index value
A – Percent erosion of A horizon	
76 – +	1
51 – 75	2
26 – 50	3
1 – 25	4
0	5
B – Depth to impermeable subsoil-inches	
0 – 6	1
7 – 12	2
13 – 18	3
19 – 24	4
25 – +	5
C – Great soil group	
Planosol	1
Gray-brown podzolic	2
Brunizem and colluvial complexes	3
D – Color surface soil (Munsell value)	
Light – 4's, 5's, 6's	1
Dark 2's, 3's	2
E – Exposure	
Exposed	1
Protected	2
F – Aspect	
South and west	1
North and east	2
G – Cultural treatment	
Cultivated intensively	1
Pastured	1.5
Uncultivated, unpastured	2
Formula: Ash site quality index = (A+B+C+D+E+F)xG[1]	

[1]This formula is an example of how site data can be arranged for practical field use by foresters in identifying site quality. The index values applied to the various environmental factors are empirical but weighted by rational judgment and fitted by trial-and-error. The principal merit of the above scheme is its close approximation of observed growth. Other values and formulae might have given similar results.

that nitrogen nutrition might be a major factor limiting growth of ash on old-field sites.

In addition to degree of erosion and land treatment, the growth of ash was related to thickness of rooting zone, great soil group,[3] color of surface soil, exposure, and aspect. An analysis of variance was not made to determine the proportion of variation contributed by each of these variables, because of incomplete and unequal sampling among given soil-site divisions.

[3]Great soil group—group of soils having major profile characteristics in common. See Simonson, Roy W., F. F. Riecken and Gay D. Smith. Understanding Iowa soils. Wm. C. Brown Company, Dubuque, Iowa. 142 pp. 1952.

By combining all the above site factors into three broad groups (past land use treatment, soil quality as judged by erosion and depth of rooting zone, and microclimate) it is possible to observe the effect of site factors on the mean annual height growth of ash (Table 3). These groups were subdivided into the classes described in Table 3. Interpretation of all the data advances the premise that past land treatment, probably through its effect on soil chemical conditions, was the most important factor influencing growth, that soil physical features were of second importance, and micro-climate of least consequence.

An empirical method, based on seven site factors, was devised for predicting the growth rate in early youth of ash planted on the investigated sites. A range of values was assigned to each of the seven different site factors (Table 4). These values were based on rational judgment and trial and error and were weighted according to apparent importance. For each of the 36 ash plots, the site quality index was calculated by the formula given in Table 4. The average annual height growth then was plotted on the calculated site quality index. The data fitted the curve of a quadratic equation (Fig. 5). The correlation coefficient between the observed values for mean annual height growth and the calculated site quality index values was 0.94.

This empirical method needs fur-

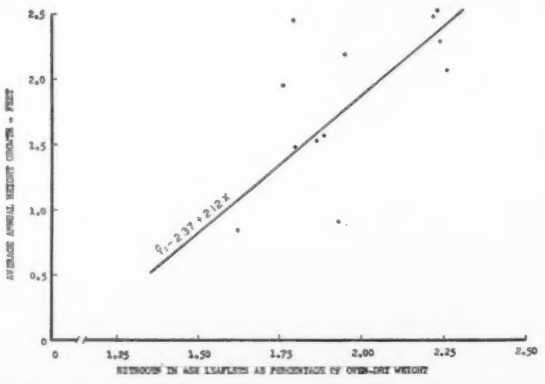

FIG. 4.—Regression of average annual height growth on nitrogen content of ash leaflets.

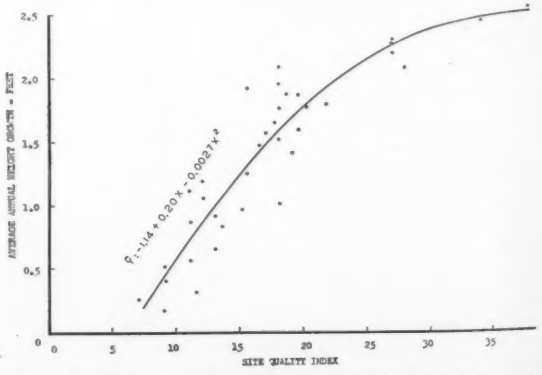

FIG. 5.—Regression of average annual height growth for ash on calculated site quality index.

FIG. 6.—Differential response of black walnut, 15 years old, to site. *Left*, Average stand height 4 feet. *Center*, Average stand height 20 feet. *Right*, Average stand height 31 feet.

ther field checking. From the data so far available it would appear to have value in site prediction for green ash in the Weller-Lindley soil association area of southern Iowa.

Black walnut.—Thirty-eight plots of black walnut located chiefly on bottomland, cove, and lower slope sites were measured and described. As in the case of ash the survival of walnut was not influenced by site. The average mortality within plots was 23 ± 16 percent. The range in average annual height and diameter growth among plots was 2.6 to 0.2 feet and 0.42 to zero inches, respectively. Although there were great growth differences among plots (Fig. 6) the correlation with observable soil characters was poor.

Numerical scales were devised for rating the soils on the plots with respect to characteristics which could be observed in the field and used by practicing foresters in evaluation of planting sites. The rating scales applied to (1) thickness of well-aerated, water-retentive soil materials, (2) soil aeration, and (3) soil color. Each factor was considered as a logarithmic function of the effective rooting depth, i.e. for a given soil profile each added increment of soil depth became less effective in increasing the site index. The soil thickness index was based on the depth of the effective rooting medium composed of water-retentive soil textures (loam, silt loam, sandy clay loam, clay loam, and silty clay loam) above a restrictive rooting zone (impermeable horizon or zone of poor aeration) or to coarse textured subsoil. Aeration was judged by the amount of mottling and occurrence of iron concretions. Soil color, as measured by Munsell[4] color chart, was used as an indicator of organic matter and possible nutrient status.

For each of the 38 plots the average annual height growth was plotted on the soil depth index, aeration index, soil color index, and and the composite index of all three variables (Fig. 7). Linear regressions were fitted by least squares. The regressions on soil depth index, soil color, and the composite index were highly significant and the aeration index was significant, but the correlation coefficients were low.

Table 5 shows the association of growth with observable soil characters and describes the subdivision of soil classes. As witnessed by these data, walnut growth was greatest on the plots having the deepest, darkest-colored, and best-aerated soils. The general site classification used has some utility for estimating walnut site quality on abandoned lands in the claypan region of southern Iowa. However, the mere observation of soil features is not adequate for consistently predicting suitable walnut sites. For the best of the above site classes, the a_1, b_1, c_1 group, the average annual height growth for the seven plots within this class varied as follows: 2.6, 2.0, 1.7, 1.6, 1.1, 1.1, and 0.4 feet. Thus, less than one out of three of the excellent appearing soil-sites was suited for black walnut.

Evidently, other site factors, not measured or described, are limiting the growth of walnut on these sites. A more complete study of the nutritional factor and of other physical characters of these sites is now being carried out, with strong indications that nutrient deficiencies as well as physical properties are important in determining walnut site quality in this area.

[4]Munsell Book of Color. (Hue 10 YR) Munsell Color Company, Inc, 10 East Franklin St., Baltimore 2, Md.

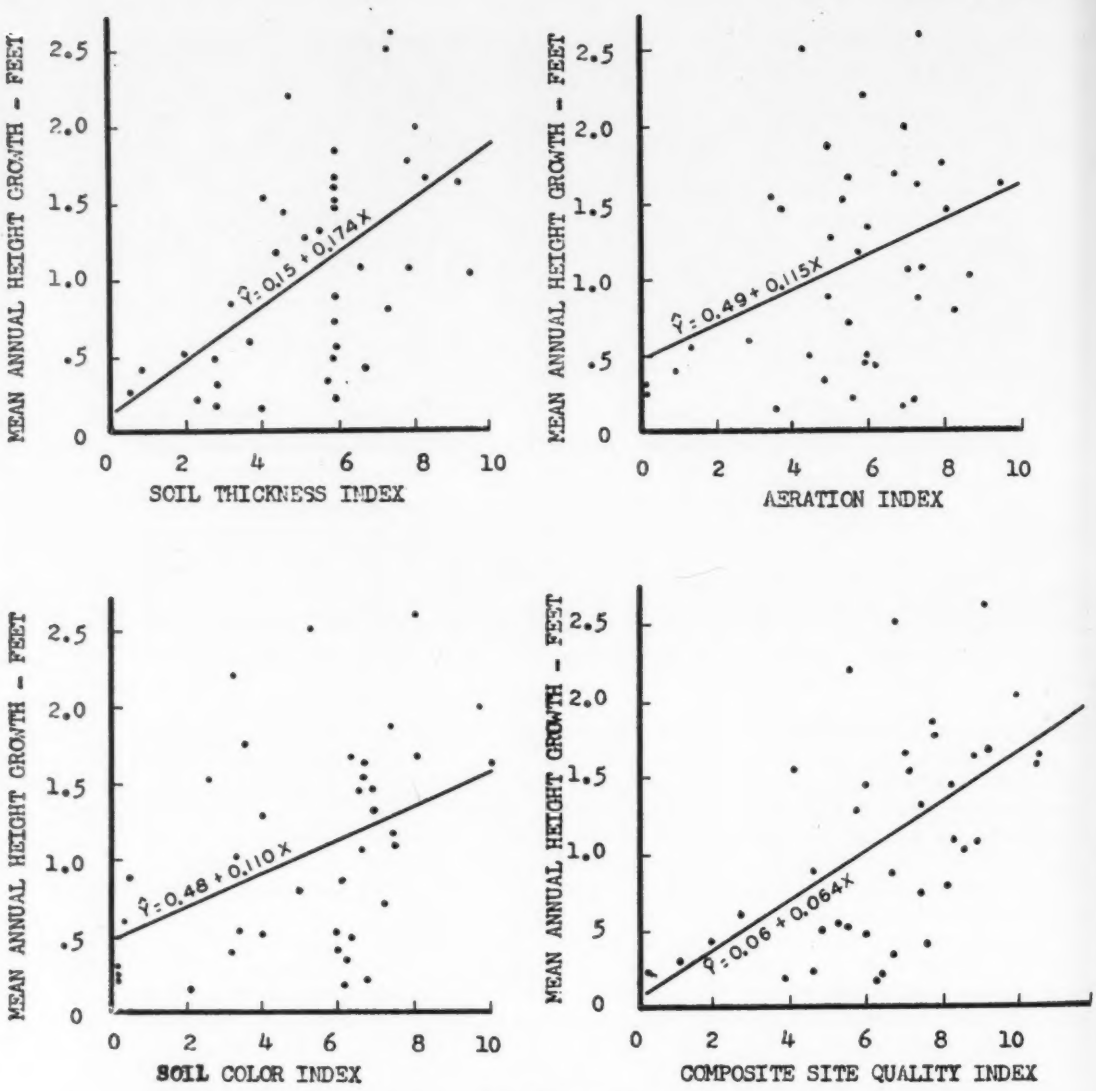
MEAN ANNUAL HEIGHT GROWTH - FEET
SOIL THICKNESS INDEX
$\hat{Y}$ = 0.15 + 0.174X
AERATION INDEX
$\hat{Y}$ = 0.49 + 0.115X
SOIL COLOR INDEX
$\hat{Y}$ = 0.48 + 0.110X
COMPOSITE SITE QUALITY INDEX
$\hat{Y}$ = 0.06 + 0.064X

FIG. 7.—Regression of height growth of black walnut on indices of soil characters.

Discussion

The results of this study emphasize again the hazards of planting many native broadleaf species on abandoned old-field lands. The principal results reported are for green ash and black walnut, species which ordinarily are considered to have high site requirements. Nonetheless red and bur oak, elm, and a variety of other broadleaf species represented by only one or two plots and not reported here, responded similarly. In contrast to the broadleaves several introduced pine species have grown satisfactorily for a period of 18 years.

During the Civilian Conservation Corps period, ash, probably because it survived well and was easy to grow and plant, was widely used in reforestation. This study has confirmed the observation of good survival but has shown that the height and diameter growth of ash is satisfactory on only a few sites. Ash seemed to be especially sensitive to site deterioration associated with erosion and, where the entire A-horizon had been removed, 15-year-old trees, growing on the clay-pan B-horizon, were often only three to eight feet in height. Massey and Jackson (*8*) found that eroded soil material from four locations in Wisconsin contained 2.1 times as much organic matter, 2.7 times as much nitrogen, 3.4 times as much available phosphorus, and 19.3 times as much exchangeable potassium as the soil as a whole. In the case of the Weller-Lindley soils the loss of nutrient elements and organic matter, and especially the decrease in depth of soil favorable to absorption of moisture and nutrients by roots, are thought to explain most of the erosion effect.

On uneroded sites with equal rooting zone depths and similar textures there were also marked

differences in growth of ash apparently associated with past land use. On uncropped and unpastured areas, particularly around farmsteads, ash grew very well. Analyses of leaflets showed that nitrogen as a percentage of dry weight was considerably lower for trees growing on previously cropped and pastured fields than on those areas not heavily pastured or continuously cropped. Other important nutrients possibly were affected in a similar manner. On Kansas soils Hide and Metzger (*5*) reported a loss of 37 percent of the carbon and 32 percent of the nitrogen from the surface soil, and 25 and 20 percent of the carbon and nitrogen respectively, from the subsurface soil as a result of cultivation and cropping. On Piedmont soils in Georgia, Giddens and Garman (*3*) found that cultivation increased volume weight from 1.14 to 1.45 while pore space decreased from 59 to 45 percent. At the same time organic carbon decreased from 1.31 to 0.44 percent, total nitrogen from .093 to .040 percent and carbon-nitrogen ratio from 14 to 11. The water infiltration rates and water-holding capacity also were decreased and the dispersion ratio increased.

On previously cultivated and eroded old-field sites a number of factors are apparently operating in decreasing the available water supply, in altering pore space and aeration, and in affecting soil microbiology related to the mineralization and mobilization of nutrients and to healthy root-soil fungus relationships. This study suggests that within the Weller-Lindley soil association area the early growth of ash can be predicted with useable accuracy from field study of sites.

With respect to black walnut, site quality could not be predicted with satisfactory probability from readily observable soil-site characteristics in the old-field areas studied. The survival of walnut, like ash, was not markedly influenced by site variations, but height and diameter growth showed extreme variation. On the poorest site 15-year-old trees were only two and one-half feet tall while on the best site the trees of similar age were 40 feet tall. Growth was satisfactory in less than five percent of the walnut plantations. On the basis of soil-site characteristics easily observable in the field the chances were about one in three of picking a site on which average height growth would exceed 2 feet annually for the first 15 years. Obviously, growth related factors not readily recognized by field study and inspection were important in walnut growth. Past land use practices probably affect the quality of soils for walnut as well as for ash. However, most of the walnut plantations studied were on bottomland sites little subject to erosion and sometimes subject to overflow, consequently it was not possible to readily judge the extent of past land use. A continuation of this site study is revealing important differences relating to nutritional factors.

TABLE 5.—MEAN ANNUAL HEIGHT GROWTH IN FEET OF BLACK WALNUT BY SOIL DEPTH,[1] SOIL COLOR,[2] AND SOIL AERATION[3] CLASSES

Soil color	Soil depth index class a_1	a_2	a_3	Average growth by soil color class
b_1	1.4/10[4]	1.3/11	0.4/4	1.2/25
b_2	2.5/1	0.8/10	0.3/2	0.8/13
Average growth by soil depth	1.5/11	1.1/21	0.3/6	1.1/38

Soil aeration	Soil depth index class a_1	a_2	a_3	Average growth by soil aeration class
c_1	1.6/8	1.2/12	0.3/3	1.2/23
c_2	1.2/3	0.9/9	0.4/3	0.8/15

Soil aeration	Soil color b_1	b_2
c_1	1.3/19	1.2/4
c_2	1.1/6	0.7/9

[1] (a_1) 38 inches or more of well-aerated, moisture-retentive soil.
(a_2) 19 to 37 inches of well-aerated, moisture-retentive soil.
(a_3) 1 to 18 inches of well-aerated, moisture-retentive soil.
[2] (b_1) 18 inches or more of dark colored A-horizon soil.
(b_2) Less than 18 inches of dark soil.
[3] (c_1) 18 inches or more of soil free from prominent mottling and/or concretions.
(c_2) Less than 18 inches of surface soil free of mottling and concretions.
[4] Number of plots for the mean annual height growth.

The existing plantations of introduced pines indicate that they will yield, at the least, merchantable crops of Christmas trees and greens, posts, poles, and pulpwood on oldfield sites where broadleaves fail to produce merchantable material. On some sites small or medium sawlog production can be expected, but rotations probably will be short. On many sites pines make exceptional growth in height and volume for 20 to 30 years. Fifteen-year-old plantations in the area studied frequently contain 100 to 125 square feet of basal area. A little farther north plantations of 35-year-old red, white, and Scotch pines, on eroded old-field soil of coarser texture, had 200 to 225 square feet of basal area. There is evidence (*7*) that on many of these sites height growth will decline more rapidly than expected after 20 to 35 years.

The results of the present tree plantings on farms under the Conservation Reserve of the Soil Bank and the Agricultural Conservation Program will influence the attitude that farm operators and managers have of professional forestry. The tree plantings must result in good survival and fast growth of merchantable species to gain the confidence of farmers in reforestation. Only the worst farm land is turned over for growing tree crops. Poor farm land usually is poor tree land, but there will be a wide variation in site quality of the land offered for forestation. Therefore, sites should be classified so that the best can be attended first with the right species in order to secure the greatest benefit for the owners and the public.

Summary

During the period 1938-1941, coniferous and broadleaf species

were established by the Civilian Conservation Corps in plantations on old-field sites in the Weller-Lindley soil association area of southeastern Iowa. Most of the soils belong to the gray-brown podzolic great soil group. They are formed from loess and glacial till, are old, highly weathered, and usually have a fine-textured B-horizon (claypan) at 12 to 24 inches from the surface. On flatter upland ridges, terraces, and some bottomlands there are planosols which, because of relatively impervious claypans, are very poorly drained and aerated during periods of high rainfall. The surface layers of these soils are mostly loam or silt loam, and the B-horizons are clay loams or silty clays. The site index of oak commonly ranges from 45 to 55.

Growth and survival of plantation trees were studied in this area. With green ash, black walnut, and other species distributed over a variety of sites, an attempt was made to correlate growth with easily observable soil-site characteristics. The growth of the broadleaves is compared with that of pines planted on similar sites.

The principal results of this study are:

1. Pine species have been growing satisfactorily for 18 years and are beginning to produce merchantable wood products. In contrast, most broadleaf species could not be expected to produce merchantable material.

2. Height and diameter growth of ash were inversely correlated with the degree of erosion of the A-horizon.

3. On uneroded areas there was great variation in growth of ash. On these sites height growth was directly correlated with leaflet nitrogen, and high nitrogen and good growth were obtained on previously uncultivated soils.

4. An empirical method of predicting early height growth of green ash in the Weller-Lindley area, based on numerical ratings of seven site factors, was developed. The factors used were degree of erosion, depth to subsoil of low permeability, great soil group, color of surface soil, aspect, degree of exposure, and past land use.

5. The growth of black walnut was significantly correlated with (1) the texture and depth of the rooting zone, (2) presence of mottling and iron concretions indicative of internal drainage and aeration, and (3) color of the surface layers as indicative of the content of organic matter and possibly the supply of plant nutrients. In all cases the correlation coefficients were low and it was not possible to predict walnut growth on the basis of easily observable site factors.

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Forestry Projects Win National Science Fair Awards

Programs designed to develop the interest of science-minded high school students in forestry may prove highly productive.

A report from the National Science Fair, held May 7 through 10 in Flint, Mich., mentions two outstandingly good forestry projects, both of which won awards in the national competition. Exhibits were entered by 281 finalists representing 146 large regional or state fairs.

Erie Lawrence Rickes, 18, of Rahway, N. J., was given a first place award for his research on Dutch elm disease and his attempt to find a method of control through study of the nutrition of the fungus.

The source of Eric's interest in Dutch elm disease was a newspaper article on the subject. He plans to study medicine in college.

A fourth place award was won by Jan Willem van Wagtendonk, 18, of Bloomington, Ind., for his study of land use in the watershed basin of a proposed reservoir and his recommendations for reforestation of the land. He exhibited a relief map of the reservoir, area, indicating open and forested land, and presented data on surveys of the area.

Jan's interest in working on this project was aroused by his observations of present uses of the land. He plans to enter college in the fall to prepare for a career in forestry.

The National Science Fair is conducted by Science Service, through its Science Clubs of America, with headquarters in Washington, D. C. The national event became international in scope this year with the affiliation of science fairs in Hawaii, Japan, and Army Dependents' schools in Germany and France.

When the fair is held in Hartford, Conn., in 1959, many new science fairs will be represented. Puerto Rico, Thailand, and other countries plan to send finalists in addition to those from a number of newly affiliated fairs in this country.

Cultivating and Fertilizing a Slash Pine Plantation: Effects on Volume and Fusiform Rust

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BOGGESS AND STAHELIN (*2*) reported on the incidence of fusiform rust (*Cronartium fusiforme* [A. and K.] Hedge and Hunt) in a slash pine plantation in Alabama that had received various cultural treatments. Their results showed an increase in incidence of rust on pines that were cultivated and fertilized. However, at eight years of age, the cultivated and fertilized plantations had produced one and one-half times as much wood as plantations not cultivated or fertilized. The volume of rust-infected trees was four times as great on the treated plots as on the control plots, but the volume of healthy trees was not affected by treatment. These same plots were remeasured after the 19th growing season, and the results are presented in this paper along with chemical and physical analyses of the soil and litter.

The experiment consisted of eight ¼-acre plots planted to slash pine in 1938 at a spacing of 8 by 8 feet. The experimental area was a gently sloping (northerly aspect) field that had been out of cultivation for several years. The soil type is Chesterfield sandy loam. Three treatments used were:

1. No treatment (control).
2. Trees cultivated and fertilized; each tree received an application of 0.3 pound of a 1-5-4 analysis fertilizer (202 lb. per acre). After growth had started, a side dressing of 0.1 pound of nitrate of soda was applied (67 lb. per acre).
3. Trees cultivated and fertilized as in treatment 2; and cotton planted between the rows with an additional application of 325 pounds of 6-8-4 analysis fertilizer per acre.

Treatments were continued for three years (1938-1940). Table 1 shows the total amount of fertilizer elements applied per acre during the experiment. Trees in treatment 2 plots were cultivated each time the inter-cropped cotton in treatment 3 plots was cultivated. The cotton lint and seed that were produced more than paid for cultivating and fertilizing the inter-cropped plots.

Methods

The diameter breast high and total height of each tree on the eight ¼-acre plots were measured, and presence or absence of stem Cronartium cankers was recorded.[1] The pulpwood volume per acre in cords was computed by a modification (interpolated 0.5-inch diameter classes and 5-foot height classes) of Minor's (*6*) form class 75-79 volume table.

Four composite soil and four composite litter samples were collected after the 19th growing season from each ¼-acre plot. Four sampling lines were mechanically located in each plot to extend up and down the slope, in an east-west direction. Sub-samples were taken at four locations on each line and composited for the final sample. At each sub-sample location, a Burger infiltration cylinder (*4*) with a cross-sectional area of 100 sq. cm. was driven through the litter into the soil to a depth of 4 inches. The litter and soil encased in the cylinder constituted the respective sub-samples. The composite samples were brought into the laboratory for chemical and physical analyses.

Total nitrogen content of each composite mineral soil sample was determined by the Kjeldahl method as described by Russel (*10*). The pH was determined with a glass electrode pH meter. Potassium was extracted with boiling nitric acid (*9*), and the amount of potassium in the extract was determined by the flame photometry method with a Beckman DU Spectrophotometer. Phosphorus was extracted with HCl and NH_4F, and the amount of phosphorus in the extract was determined by a modification of the Troug method (*1*). Percentages of sand, silt, and clay were determined by the Bouyoucos hydrometer method (*3*).

After litter samples were oven dried the adhering soil was removed and the samples were weighed. The litter was then ground in a Wiley mill using a 20-mesh sieve. For each composite sample, total nitrogen was determined by means of a semi-micro adaptation of the Ranker salicylic-thiosulfate method (*8*) using a Kemmerer-Hallet distillation unit (*5*). Samples for phosphorus and potassium determination were dry ashed as described by Piper (*7*). From the ash solution, the percentage of phosphorus was determined by the A.O.A.C. colorimetric method (*1*) and the percentage of potassium by the flame photometric method.

[1]Stem cankers as recorded in 1957 include those reported as "trunk" and "limb-trunk" in 1946. Limb cankers, which accounted for only 3 percent of infected trees in 1946, were ignored in 1957 in the belief that on trees as old as these they have a negligible effect on a stand.

TABLE 1.—TOTAL AMOUNTS OF FERTILIZER ELEMENTS ADDED DURING THE THREE-YEAR TREATMENT PERIOD

Treatment	Number of plots	Pounds applied per acre N	P_2O_5	K_2O
Control	3	0	0	0
Cultivated and fertilized	2	39	30	24
Cultivated, fertilized and intercropped	3	96	108	63

Results and Discussion

It might be proper to point out here that the individual effects of

TABLE 2.—AVERAGE NUMBER OF LIVING SLASH AND LOBLOLLY PINE TREES PER ACRE AND RATE OF STEM CANKERING

Treatment	Trees per acre					Rate of stem cankering in trees 4.3 in. and up
	D.b.h. 4.3 in. and up		Below 4.3 in.			
	Slash	Loblolly	Slash	Loblolly	Total	
	No.[1]	*No.*	*No.*	*No.*	*No.*[1]	*Percent*[2]
Control	408	115	28	67	618	42[2]
Cultivated and fertilized	426	0	12	0	438	65
Cultivated, fertilized, and intercropped	452	0	4	0	456	66

[1]No significant difference, at the 5 percent level, between treatments.
[2]Control is significantly different, at the 5 percent level, from the other two treatments.
[3]Both species combined.

TABLE 3.—AVERAGE D.B.H. AND HEIGHT OF SLASH AND LOBLOLLY PINE TREES 4.3 INCHES D.B.H. AND LARGER

Treatment	Average d.b.h.		Average height	
	Slash	Loblolly	Slash	Loblolly
	Inches[1]	*Inches*	*Feet*[1]	*Feet*
Control	7.3	6.0	45	42
Cultivated and fertilized	8.0	—	48	—
Cultivated, fertilized, and intercropped	8.4	—	47	—

[1]No significant difference, at the 5 percent level, between treatments.

fertilizer and cultivation are obscured because the two treatments were applied only in combination. In the case of cultivation, the effect would undoubtedly be to increase early survival by reducing competition during the first three years after planting. That this happened is indicated by the numbers of surviving slash pines (Table 2). Loblolly pine seeded in heavily on the plots that were not cultivated. One of the control plots had even more loblolly pines than slash pines. The large number of trees on this control plot restricted the growing space. This in combination with lack of cultural treatments resulted in trees of reduced diameters and heights. There were no significant differences between treatments in the average heights of slash pine. The average d.b.h. of slash pine was not found to be significantly different between treatments (Table 3), but approached significance at the 5 percent level.

Although the control plots, with their volunteer loblolly pines, had more trees per acre than the treated plots, the basal area was about the same as the low fertilizer plots. The basal area of the intercropped treatment was significantly greater than the other two treatments (Table 4). The pulpwood volume was apparently lower on the control plots than on the low fertilizer plots, and significantly lower than on the intercropped plots (Table 4). Even with their large number of trees, the control plots averaged 36.2 cords per acre, of which 30.8 cords were slash pine and 5.4 cords were loblolly pine. The treated plots averaged 39.6 and 43.9 cords per acre for the low and high fertilizer plots, respectively, with all merchantable trees slash pine. The larger production on the intercropped plots, given the higher rate of fertilization than on the other treated plots, is independent of the effects of cultivation; and it was attained in spite of the added competition of the intercropped cotton. What would have been the effect of fertilization without cultivation is not known. It seems reasonable to suspect that the resulting stimulation to weed growth might have a highly adverse effect on seedling survival.

The percentage of trees with stem cankers and the pulpwood volume per acre in trees with and without stem cankers are shown by treatment in Table 2 and Table 4. When the plots were measured after eight growing seasons, the percentage of rust-infected trees was more than twice as great[2] on the treated plots as on the untreated plots. Now, after 19 growing seasons, the stem infection averages about 65 percent on the treated plots and 42 percent on the control plots. There was no difference in rust incidence between the cultivated and fertilized treatments.

There was no clear difference in average height between cankered and non-cankered trees. Cankered trees were taller on some plots, non-cankered were taller on others.

Soil reaction was quite uniform over the entire experimental area. The average pH of the samples collected in 1957 was 4.8. Textural grade, too, was uniform, with the exception of one control plot that was severely eroded at one edge and showed an average clay content almost three times greater than the

TABLE 4.—BASAL AREA AND PULPWOOD VOLUMES PER ACRE IN MERCHANTABLE SLASH AND LOBLOLLY PINE TREES[1] WITH AND WITHOUT STEM CANKERS

Treatment and species	Basal area per acre			Pulpwood per acre		
	Without canker	With canker	Total	Without canker	With canker	Total
Control	*Sq. ft.*[2]	*Sq. ft*[2]	*Sq. ft.*[2]	*Cords*[3]	*Cords*[4]	*Cords*[5]
Slash	65	56	121	16.4	14.4	30.8
Loblolly	15	8	23	3.7	1.7	5.4
Total	80	64	144	20.1	16.1	36.2
Cultivated and fertilized, slash[6]	54	94	148	14.6	25.0	39.6
Cultivated, fertilized, and intercropped, slash[6]	61	106	167	16.0	27.9	43.0

[1]Trees 4.3 inches d.b.h. and larger.
[2]No significant difference, at the 5 percent level, between treatments.
[3]Intercropped treatment is significantly different, at the 1 percent level, from the other two treatments.
[4]Control is significantly different, at the 5 percent level, from the other two treatments.
[5]Control is significantly different, at the 1 percent level, from the intercropped treatment.
[6]Also total. No volunteer loblolly pine on plots because of cultivation.

[2]Fifty-two percent of trees on treated plots and 21 percent on control plots with stem cankers in 1946.

other plots. Over the whole area, the average sand, silt and clay percentages of the top 4 inches were 80, 14, and 6, respectively.

A desired feature of forest stand fertilization is that the nutrient elements added as fertilizer may enter the nutrient cycle of the stand and have a beneficial effect over a period of many years. In this study, no real differences between treatments in the amounts of nitrogen, phosphorus, or potassium in the soil or litter were found 17 years after the last fertilizer application (Tables 5 and 6). The absence of real differences between the treatment means might be attributed to the small proportion of the area sampled or, more likely, to the low degree of precision obtainable by existing analytical methods with the relatively low concentrations of nutrient elements encountered in forest soils and litter. Because of even greater sampling difficulties, no attempt was made to determine the quantities of fertilizer elements in that part of the cycle represented by the living vegetation. It might perhaps be assumed that inclusion of vegetation analyses to round out the cycle would have strengthened the relationship between amounts of fertilizer elements added and amounts found later.

Nevertheless, the total amounts of nitrogen and potassium found in the litter and of phosphorus in both the soil and litter were highest on plots given the most fertilizer and lowest on plots not fertilized. There is a definite trend of greater observed amounts of phosphorus with higher rates of fertilization. The more nearly conclusive findings regarding phosphorus might be expected in view of the lower degree of mobility of soil phosphorus than that of introgen or potassium.

TABLE 5.—AVERAGE TOTAL POUNDS PER ACRE OF FERTILIZER ELEMENTS IN THE TOP 4 INCHES OF SOIL

Treatment	N	P_2O_5	K_2O
	Lbs. per acre[1]		
Control	854	148	305
Cultivated and fertilized	805	185	288
Cultivated, fertilized, and intercropped	756	217	241

[1]No significant difference, at the 5 percent level, between treatments.

TABLE 6.—AVERAGE DRY WEIGHT AND NITROGEN, PHOSPHORUS, AND POTASSIUM CONTENT IN THE LITTER

Treatment	Litter, dry weight	N		P_2O_5		K_2O	
	Tons per acre[1]	*Percent*	*Lbs. per acre*[1]	*Percent*	*Lbs. per acre*[1]	*Percent*	*Lbs. per acre*[1]
Control	22.1	.56	247	.089	39	.78	345
Cultivated and fertilized	26.6	.48	259	.089	48	.72	384
Cultivated, fertilized and intercropped	31.5	.56	346	.090	56	.67	420

[1]No significant difference, at the 5 percent level, between treatments.

Summary

In an old-field plantation of slash pine, cultivation and light applications of NPK fertilizer during each of the first three growing seasons resulted in an apparent but not significant increase in pulpwood volume of about 10 percent after 19 growing seasons. There was a significant increase in number of trees with stem cankers of southern fusiform rust on cultivated and fertilized areas. Growing crops of cotton between the tree rows with additional, somewhat heavier fertilizer applications resulted in a further non-significant volume increase of about 10 percent without a further increase in stem cankering. A significant difference of about 21 percent was found between the volume of the control plots and the volume of the highest fertilized plots.

Whether nutrient elements added in fertilization were still present in the nutrient cycle of the stands was not clearly demonstrated. However, the amount of phosphorus found in both soil and litter was least on control plots and greatest on plots to which the most fertilizer had been added.

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An Estimate of Capital Needed in Forestry to Meet Projected Timber Requirements for the Year 2000

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As the United States approaches the end of a long era of liquidation of virgin timber we face the problem of making a transition to a timber cropping economy. Encouraging progress has been made during the past 20 years in reforestation of cutover lands, protection of forests from fire, insects and disease, and in the advancement of applied forestry sciences. Nevertheless, our decisions to invest money in forestry have lacked an overall economic rationale as a basis for intelligent planning. Since timber growing takes decades instead of seasons, with long intervals between investment inputs and yields, planning entails a degree of complexity not common to most other kinds of financial forecasting.

In recent years, economists have given increasing attention to the question of proper allocation of capital investment in forestry without benefit of quantitative estimates. Some have felt that intensification of forest management should largely be relegated to a public works category to be undertaken in periods of underemployment; while a more recent feeling has developed that the current transition from a forest economy based upon growing stock liquidation to a forest cropping system must inevitably be accompanied by more systematic capital inputs. There remains, however, the problem of determining in quantitative terms the intensity of management and the size of the capital investment economically justified.

The author is fully aware of the many limitations of data in making an estimate of this nature. It must be recognized that choices in making assumptions were unavoidable and that in some instances a good case may be made for different assumptions. Nevertheless, it is felt that the time is past due for the development of a methodology in this very important aspect of forest economics. This paper is offered in the spirit that it will begin to stimulate future discussion, criticism, and further development as a basis for decision making.

Estimates of Future Timber Requirements

The Timber Resource Review (*6*) of the U. S. Forest Service has appraised our current forest situation in more detail than any of the previous efforts. Of immediate interest to this study are the overall national estimates of forest growing stock (capital), of annual rates of growth and cut, and of area primarily devoted to commercial forestry. These data are summed up in Table I.

In attempting to forecast America's capital requirements both the (*1, 3*) President's Materials Policy Commission and the Twentieth Century Fund made estimates of the investments required to increases the average annual growth from 13.4 billion cubic feet to 20 B.C.F.[1] which was estimated to be the volume of timber the nation would need in the year 2000. These estimates, which are based upon the U. S. Forest Service's Forest Reappraisal Report of 1946 (*5*), may be compared with more recent T. R. R. data which set forth several projected future demand levels for forest products for the years 1975 and 2000. Several years ago the Stanford Research Institute completed an economic forecast of timber consumption, (*4*) using similar techniques. A sizeable group of economists have concentrated on forecasting techniques with increasing refinements. In each case certain assumptions are made with regard to rates of economic growth based upon population changes and shifts in the production and consumption of the particular products being analyzed. This type of economic forecasting is gaining increasing acceptance as a process for both public and private planning, although occasionally it is still viewed with alarm. The assumptions, the techniques, and the forecasted results give rise to critical appraisals and differences of approach of which the Forest Service estimates have had their share (*2, 8*).

Although differences exist over the future levels of total timber requirements, all of the forecasts assume that we shall need to grow more timber than at present, even without any rise in living standards over the present. Even with a continuing decline in our per capita consumption it has been assumed that population increases will bring added pressure to produce still more wood. The Forest Service has set forth two projections for the year 2000, known as "upper" and "lower level" projections.[2] These upper level estimates are based on the assumption that industrial timber products will occupy the same position relative to the consumption of all physical structure materials as they did in

[1]While the cubic foot as a measure submerges quality and size considerations, convenience and simplicity make it preferable to use throughout this paper.

Table 1.—Overall Forest Situation—1952

Volumes in billion cubic feet[1]	Hardwood	Softwood	Total
Present timber volumes	162.0	355.0	517.0
Current annual growth (net)	7.2	7.0	14.2
Current annual cut (net)	3.3	7.5	10.8

[1]Present on 488,609,000 acres of commercial forest land

[2]In the final T.R.R. report (*7*) a third and higher estimate was made which relegated the "upper" projection to a "medium" projection status.

TABLE 2.—GROWTH, CUT, AND GROWING STOCK INVENTORY RELATIONSHIPS

Billion cubic feet	Hardwoods	Softwoods	Total
1952 Cut	3.3	7.5	10.6
1952 Growth	7.2	7.0	14.2
1953 Growing stock	151.0	366.0	517.0
Realizable growth	10.5	17.0	27.5
Growth needs—2000	7.4	14.7	22.1
Projected growing stock (Present trends of upper level demand with no change in management)			
Projected growth—2000 (Present trends of upper level demand with no change in management)	7.9	4.3	12.2
Required growing stock volume for year 2000	186.0	441.0	627.0

1952. Lower level estimates assume a decline in relative consumption. For purposes of this study the basic data and the assumptions underlying the "upper" level projections are the starting point from which this analysis is developed.[3] All figures used are from the T.R.R. unless otherwise indicated; and no attempt is made to deal with any but overall figures.

This writer further assumes that because of the long growth cycle of timber, plans and programs required to assure the level of growing stock needed by the year 2000 must be decided and executed within the next ten years. Capital outlays required for intensified forestry to reach this production goal are developed from estimates of the projected requirements; but the policy determinations needed to assure the required investment are not given consideration in this study.

Table 2 shows that our 1952 cut of all roundwood products amounted to 10.8 billion cubic feet, divided between softwoods (7.5 billion cu. ft.) and hardwoods (3.3 billion cu. ft.) while total growth amounted to 14.2 billion cubic feet. In terms of board feet, growth and commodity drain are about in balance. The excess of cubic foot growth over drain is due to the growth occurring in large areas of pole size timber.

The T.R.R. "upper level" estimates for the year 2000 indicate a 54 percent overall increase in our cubic foot volume growth from the present (from 14.2 to 22.1 billion cu. ft.) and more than 100 percent increase in board foot growth (from 47.4 to 105.4 billion bd. ft.). In order to obtain this growth goal, growing stock inventory accretions are called for. The Forest Service projections indicate that the impact of increasing requirements will reduce growing stock inventories by the year 2000 considerably below those of the present unless steps are taken to intensify management.

Although the specific forest management measures are not set forth, presumably they would include: (1) reforestation of all or part of the 50-odd million acres of idle commercial forest land; (2) acceleration of growth through thinnings and other stand improvement measures; (3) intensified insect, disease and fire protection; (4) elimination of premature clear-cutting of better species of young sawtimber; (5) harvest cuttings in mature stands so as to assure maximum wood production of desirable quantity, quality, and frequency interval, and (6) shifting a portion of the present cut to poorer species and stands with resultant lowering of quality for a time. This 22.1 billion cubic foot growth goal is considered easily "realizable"[4] and far below the biological potential. Data presented in the T.R.R. show that "realizable" growth would be about 27.5 billion cubic feet if these measures were applied — nearly double the present 14.2 billion cubic foot figure. Assuming that we will need only 22.1 billion cubic feet under the "upper limit" figure (54 percent above the present level) we can then go on to estimate the expenditures required.

Capital Investment Requirements

In the estimates which follow only those additional investment costs needed to obtain higher growth goals are calculated. The assumption is made that the present investment in land and timber (growing stock), and annual carrying charges, management and protection costs will continue at present levels. Therefore the estimates and forecasts which follow are only those additional inputs required for additional growth above the present 14.3 billion cubic feet. Forest development costs for roads and other improvements are considered to be either currently chargeable to harvesting or additional capital investments over and above those required for timber production. Recreational, wildlife, or watershed development and protection are not included for the same reason. It is further assumed that the level of harvesting would be kept to the allowable cut but would increase yearly as the growth potential increased. This assumption is based on the fact of excess cubic foot growth over present cut which amounts to an annual addition of 3.2 billion cubic feet to growing stock. The increase in annual growth and cut above the present level (14.2 billion cu. ft.) would be attributable to the added capital inputs. However, some shift into lower quality material may be required.

Since no T.R.R. estimates have been made of the physical input of intensified forestry measures which

[3] The greater timber abundance implied in the upper level estimates should certainly be reflected in a price relationship favorable to a larger consumption than that possible under the lower level estimates. The economic question of justification of the capital investment required is the only factor treated in this analysis. The broader aspects of reserve stumpage supplies for future unexpected contingencies (national defense, shift from other declining resources to wood, etc.) are not covered because of difficulty of quantitative measurement.

[4] "Realizable" growth is estimated to be the growth which would result if all commercial forest lands were managed at about the same intensity as that now taking place on the better private and public forests. It has been assumed that half of this class of timber either will not need treatment or any cost of treatment will be self-liquidating: (1) since much of it will approach normal stocking as it advances in age—particularly the hardwoods which make up a large share; and (2) since many of the better stocked stands will produce an income from thinnings to offset any silvicultural costs.

would be required to attain the 22.1 billion cubic foot growth it became necessary to make approximations for this purpose. Of the six intensified forest practices suggested previously, the first three require capital investment which can be estimated, whereas the last three involve postponement of income in some cases, and modifications of harvesting practices in others with attendant additional carrying charges. Since these latter measures depend heavily upon both owner and public policy determinations, estimates of carrying costs would be of little value at this point.

This paper further assumes that full application of these minimal silvicultural measures would produce the "realizable" growth estimated in the T.R.R. at 27.5 billion cubic feet. An investment in forest practices previously set forth would involve planting of 52 million acres of nonproductive land, the application of such practices as underplanting, weedings, thinnings, and pruning to all of 114 million acres of understocked lands and approximately half of the 324 million acres of medium to well stocked stands.[5] It would also require that adequate fire protection and insect and disease control programs be extended to all currently unprotected areas. Since no cost studies showing weighted average costs of forest planting or stand improvement measures are available, the writer obtained data from several sources and regions. While the data are admittedly estimates, they tend to be high and hence would give conservative results. Again, the reader is asked to assume these cost figures until better data become available.

While the present expenditures for protection and management are not included in this calculation, it is of interest to point out that the present level of growth (14.3 billion cu. ft.) is being produced under generally extensive management at a current annual cost of $175 million[6] according to an estimate supplied by the Forest Service. If the previous assumptions are granted, it can be estimated that the $4 billion investment in forest management made within 10 years and coupled with sufficient restraint to build up forest growing stock over the balance of this century could result in an increase of nearly 92 percent in annual wood production (27.5 billion cu. ft.). Actual needs, however, were determined to be only 22.1 billion cubic feet or about 54 percent above the present level. Applying this percentage to the total estimates for the larger growth figure, an additional investment of $2.1 billion is indicated to attain our desirable growth goal. If this were to be made over the next decade it would require annual expenditure of slightly more than $200 million.

Assuming that growth is increased at a steady rate from 14 to 22 billion cubic feet per year over a 40 year period as a result of more intensive forestry, the mean annual growth rate would be about 18 billion cubic feet or about 4 billion cubic feet above present levels. (Actually there would at first be somewhat less than 4 billion cu. ft. due to gradual curve increase in growth rather than straight-line projection). In addition there will be accumulated in forest capital 110 billion cubic feet of growing stock. Using the stumpage value of $0.065 per cubic foot this additional 4 billion cubic feet of increased annual growth which can be attributed to intensified silvicultural treatment is valued at 1956 prices at 260 million dollars.[7]

These growth assumptions would mean that the average annual growth would increase from the present level of 29 cubic feet per acre to 45 cubic feet per acre over the 40 year period. This increase of 16 cubic feet between the beginning and the end of the period would be at the annual rate of .4 of a cubic foot. Silviculturally this can be obtained by a combination of withholding growing stock, by a reduction of mortality losses, by increasing growth rates through cultural treatments, and adding more timber producing land through planting.

TABLE 3.—ESTIMATED COSTS OF PLANTING AND STAND IMPROVEMENT

Silvicultural practice	Estimated cost per acre[1]	Acreage applicable	Total costs
Forest planting	$23.00	52,000,000	$1,196,000,000
Stand improvement[2]	10.00	276,000,000	2,760,000,000
Total	-----	-----	$3,956,000,000

[1]Does not include cost of land or annual carrying charges since these are assumed to continue at present level. All prices are at 1956 levels. Based upon state, Forest Service and paper company weighted average estimates obtained independently by the author.

[2]Includes thinnings, release cuttings, weeding, some pruning, and girdling. Based on Forest Service experimental forest and Agricultural Conservation Program cost data roughly averaged to give an approximation for a variety of forest types and conditions and is the net cost after income from any products is considered. Both this practice and planting costs are based upon state, federal and private data obtained by the author and weighed according to regional and other factors.

Additional Protection Measures

These estimates do not include additional fire, insect, and disease prevention, detection, and control measures that will be required under more intensive management levels. Present expenditures by all agencies are around $80 million annually. It is estimated by the writer from data supplied by the Forest Service that an increase of $40 million, to a total of $120 million,

[5]It is roughly estimated by the writer that stand improvement work on the better stocked pole and sawtimber stands of better hardwoods and all conifers will be self-liquidating and require no capital inputs. This estimate is based upon stocking and yield data for well managed public and private land.

[6]Although Table 2 shows that annual growth will drop to 12.2 b.c.f. if no improvements are made in forest practices above present levels by 2000 A.D., it is assumed that some improvements in management will occur and that these will be sufficient to maintain current output in spite of increased pressure.

[7]Four billion cu. ft. converts to 21.8 billion bd. ft. at rate of 184 cu. ft. = 1 M bd. ft. at a 1956 weighted average national stumpage (including both sawtimber and pulpwood) price of $12 per M bd. ft., or .0652c per cubic foot.

would provide reasonably adequate protection. Such an expenditure would not be a capital investment but an increased current expense of $40 million above present levels and chargeable against current annual forest increment.

A considerable reduction in current losses in growth due to mortality (estimated by the Forest Service at 2.7 billion cu. ft. or 9.6 billion bd. ft.) may be expected as a result of this expenditure. At the assumed stumpage prices present losses amount to $115 million per year (fire, insects, and disease account for about $65 million; the difference being due to weather, animals, and all other destructive agents.) If it may be assumed that the losses from fire, insects, and diseases can be reduced to $25 million from more intensive protection (but none of the other losses), the net value of growth saved ($40 million) would be equal to the added protection expense. This self-liquidating current expenditure could result in making additions to growing stock which should offset to a significant extent, if not completely, the need for reducing the allowable cut in order to accumulate required amounts of growing stock. If the cost of additional protection is self-liquidating (as expected) it need not be included in the investment estimates.

Economic Analysis

A determination of the economic feasibility of the capital investment indicated involves analysis of several concurrent factors. If the calculated capital investment of 2.1 billion dollars is made in the year 1960 (physical and economic limitations would actually spread this over a decade) for intensive silvicultural applications which will produce an additional 4 billion cubic foot of a v e r a g e annual growth[8] valued at 260 million dollars, the increase in forest growing stock (capital) during the 40 year period of 110 billion cubic feet would amount to an addition to capital value at 1956 prices of $7.2 billion in the year 2000.

The analysis then involves two factors: an i n c r e a s e d current growth and the addition to growing stock. The first item will produce an annual gross return of $260 million. The second item will produce capital valued at $7.2 billion by the year 2000.

These gross yields do not include all a d d i t i o n a l carrying charges. If it may be assumed that protection costs are accounted for, taxes or tax equivalents are not, nor are extra administration and management costs.

To determine net returns and interest earned on the investment we may assume for purposes of this estimate that carrying charges will be met from the additional current growth at about the same proportion as on the National Forests. From the $260 million gross annual yield, 25 percent ($65 million) would be deducted for taxes, leaving $195 million. If we assume an added administration and management (but not protection) cost of $55 million above present levels,[9] a net annual return of $140 million could be expected. The simple interest rate earned on the investment would average slightly more than 6 percent on the $2.1 billion investment over the 40 year period and actually to infinity. If the assumption that reduced mortality will offset additional protection costs is not accepted, this $140 million would be further reduced to $100 million. The earned interest rate would then be just under 5 percent. (Simple interest is used because the increased yields would be realized soon after the investment is made and during the ensuing 40-year period.)

In addition the increase in capital of 110 billion cubic feet valued at 1956 prices would amount to $7.2 billion. These estimates appear to give a favorable ratio of costs to net yields, whereby a given capital input returns nearly 5 percent interest per year.

There are certain elements in the equation which bear further examination. In the first place, these estimates include certain policy assumptions which would withhold the thriftiest and most rapid growing stands of young timber from premature cutting (which alone would cause some rise in yields without additional capital inputs). Secondly, the cut would be thrown on to the poorest quality trees and thus lower the average value of the current yield for several decades below those shown above. And, thirdly, there would be large volume of "in-growth" whereby young immature second growth would cross over the line to marketability without any additional capital investment. Finally, there would be denser stocking per acre with resulting higher quality and value of yields.

In other words, some of this additional current growth and growing stock inventory would take place regardless of new capital inputs—*if* more protection and better forest management would be adopted. Then, too, the fact that present forest production is well below optimum output levels while fixed costs are relatively stable makes for a situation where a small increase in inputs will yield a large output increase.

The above additional variables with little or no basic data with which to gauge them are such that measurement [of them] would require the development of still further assumptions. Since much of the case already rests on a number of assumptions which are based on such data as are available, further calculations of this sort might well be fertile ground for those who may wish to pursue this subject.

Discussion and Summary

Any estimate of the future must necessarily rest upon a series of dependable assumptions. Also, where basic data are absent or incomplete, the author obtained the best estimate possible. There is no other course; yet by their very nature, assumptions may be challenged at any of a number of points. This paper is offered mainly as a meth-

[8] Recognizing that this is a crude approximation since the time distribution of growth will actually be depicted by an experimental function.

[9] Estimated cost of applying management and supervision to forest lands not now managed (17 cents per acre on 325 million acres).

od for arriving at an approximation of the investment needed in more intensive forestry under the conditions set forth. It is to be hoped that this effort will stimulate additional constructive thought on the part of forest economists in this important area.

What proportion of our total national investment effort can properly be allocated to forestry as compared with other opportunities has been a moot question among economists. This paper has broadly estimated the amount of capital that would be needed to achieve "upper limit" growth goals of 22.1 billion cubic feet by the year 2000. Necessary measures to bring about improved cutting practices so as to accumulate additional forest capital have been assumed but policies to assure these practices have not been set forth.

The estimates presented indicate that a capital investment of $2.1 billion over the next decade plus an added $40 million in annual protection outlays for a 40-year period will produce an added 4 billion cubic feet of annual growth with a gross value of $260 million (net of 140) per year for the whole period prior to the year 2000. This study did not attempt to allocate the capital costs between private and public forests but would expect them to be somewhat proportional to ownership.

In estimating capital requirements for timber production it is of interest to make relevant comparisons. In 1955 the United States made capital investments amounting to $56.4 billion—16 percent of our total national income of $324 billion. About $175 million was invested (i.e. .2 of 1 percent of our total capital investment) in forestry in the same year to protect and cultivate our national timber crop for the support of our forest-based industry which contributed an estimated $15 billion (4.7 percent to the national income total (*1*).

Thus we are currently spending 1.2 percent of the gross income generated by forestry to produce basic raw material. An additional annual investment over a 10-year period of $210 million would add another 1.4 percent to the investment cost of timber production for 10 years—which, if added to cost of forest products, would be small in relation to the indicated timber yields.

The determination of how much to invest in forestry should properly include other criteria than interest rate earned; but in any case interest rate will weigh heavily in private forestry decisions. On all forest lands nonmonetary returns are a factor which can only be resolved through other than marketplace processes—especially on public lands. This paper does not attempt to deal with these politico-social aspects of investment decision making. It may be hoped that these may be brought out in subsequent discussion.

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GEORGE A. GARRATT, Society of American Foresters president, spoke at the 19th annual Keep Washington Green Governor's Banquet held recently in Seattle. The banquet, sponsored jointly by the Society of American Foresters and the Keep Washington Green Association, was held to kick off the 1958 forest fire prevention season. Master of Ceremonies "Gummy" Johnson looks on.

The Economy of Intensive Management of Forest Lands As It Applies To Site Preparation and Land Regeneration[1]

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THE MATTER OF site preparation, though relatively new, has caught on fast in our southern states during the last few years. As a matter of fact, there can hardly be any doubt in a southern forester's mind that the outstanding single management treatment being applied to forest ownerships in this region is site preparation. As we all know, southern industry, particularly the pulp and paper industry, is spending many thousands of dollars in preparing nonproductive or partially productive areas for plantation establishment or natural regeneration.

The majority of site preparation work is accomplished by employing the various makes of tractor equipment with accompanying attachments such as two-section harrows, choppers, chains, rakes, and an assortment of cutting blades. Becoming increasingly popular is the aerial application of 2,4,5-T on areas that present a hardwood problem and those which are topographically unsuited to the operation of mechanical equipment.

The economics behind this intensive phase of applied management can be calculated only within certain limits. For example, we can only assume or guess what the value of our timber crop will be 20 or 25 years hence. We do know right now that available timber lands of average to above average site quality are certainly becoming more and more difficult to secure as land acquisition competition intensifies because of the rapidly expanding pulp and paper industry. With this in mind, it would appear not only feasible but necessary for industry to embark on a program utilizing intensive forest management practices for the purpose of putting their lands into shape for maximum production as soon as possible. With maximum production as a goal, we cannot afford as managers, to have these non-productive or even partially productive acres within our forest ownership and justify the investment in such lands.

Most of the forest land under corporate ownership in the Southeast contains at least small acreages of every type or condition that would necessitate treatment to place such acreage in an optimum growing condition. Following are the type areas that are presently being considered, by foresters, for site preparation or conversion:

1. *Turkey oak or scrub oak ridge.* The poorer, but not necessarily nonproductive areas. These sites are usually medium to deep sands with a light wire-grass cover under the oak.

2. *Pine-hardwood ridge.* This type normally consists of a scattered stand of pine and an understory of hardwood brush that limits or eliminates chances for natural reproduction. These areas comprise our medium to strong sites.

3. *Pond, swamp, pocassin, or bays.* (Other than those desired as hardwood production areas.) It is possible to treat the margins of these wet, brushy areas with mechanical equipment and recover a portion of this acreage for pine. The most practical approach to converting the interiors appears to be a combination of drainage and aerial spraying, followed by planting or aerial seeding.

4. *Partial pine stands.* Areas on which the growth percent is limited either by poor stocking or stand condition. Ground cover may be oak brush, sweetgum, palmetto, various grasses, gallberry, or a combination of these.

5. *Forest type conversion.* Areas that we simply want to convert from one species to another more desirable species, for example, longleaf pine to slash pine or inferior hardwood to pine.

Land preparation treatment, conservatively applied, should not cost more than $10 to $12 per acre, on the average, using existing equipment and practices. Foresters should then be able to justify such an expenditure on a sound economic basis before embarking on an extensive land or site preparation program. This average cost figure should reflect all of the different types of preparation applied as well as the different degrees of preparation applied. For example, treatments may range from a single light disking of the site with an offset harrow to those requiring a brushcutter, a hot fire, two trips with a harrow, plus manual girdling of the large, individual hardwoods.

Probably the best way to illustrate the "cost" and "yield value" relationship of any woodlands operation is to use a sample problem. Let us assume that we wish to put into full production an area having a site index of 70 for slash pine and want to allow 5 percent interest on the investment for, let us say, a pulpwood rotation of 25 years.

Let us assume that our costs are as follows (Table 1, site index 70): site preparation, $10 per acre and machine planting, $8 per acre. This means that we are spending $18 per acre in putting the land into full production. This sum compounded at 5 percent for 25 years amounts to $60.95. Management and ad valorem tax costs of about $1.50 per year must also be considered, and this cost differs from the others in that it occurs annually. Compounded for 25 years at 5 percent interest, the value of this cost would be $71.60. The total value of our costs, on a per acre basis, at the end of the rotation would be: $60.95 plus $71.60

[1]Presented at the meeting of the Southeastern Section, SAF, January 24, 1958.

or $132.55. The normal yield for a 70 foot slash pine site at 25 years is approximately 34 cords per acre. This figure is conservative as we are now talking in terms of a plantation; however, using this volume and assigning a value of $5 per cord for stumpage, we have a wood value of $170 per acre in 25 years. Subtracting our cost of $132.55 from this figure leaves us $37.45. This can be considered the value of our wood at 25 years allowing 5 percent interest on costs but before any allowance for carrying the value of our land. Of course, the net wood value at our chosen rotation age could very well be much higher if the value of the stumpage would rise appreciably during this time. It should be pointed out here that many paper companies would be satisfied to break even at the end of the rotation, as the primary function of the woodlands department has been, and probably always will be, to insure as nearly as possible a continuous supply of wood for the pulpmills. It is also important to note that site preparation, planting, and management costs might remain the same whether we are working with a 70 foot site or a 90 foot site. The return over "n" number of years, however, will be much greater on the latter. For example, the normal yield for slash pine on a 90 foot site at 25 years is 48 cords per acre (Table 1, site index 90). At $5 per cord stumpage, this would give us a per acre wood value of $240 as opposed to $170 for the 70 foot site, a difference of $70 per acre.

Perhaps a better way to illustrate the "cost" and "yield value" picture of woodlands would be to consider intermediate cuttings during the aforementioned rotation of 25 years. The idea being, of course, to cut down on the initial investment as soon as possible. If we were to use the same cost figures and reduce our investment, by thinning, at 15 years and 20 years, we would have a net wood value at the end of 25 years that would considerably exceed the example figure.

TABLE 1.—ASSUMED COSTS AND RETURNS FROM SITE PREPARATION ON TWO SLASH PINE SITES, 25-YEAR ROTATION

Site index 70 (Slash pine)		Site index 90 (Slash pine)	
Site preparation	$ 10.00	Same as site index 70	
Planting	8.00		
Total	$ 18.00		
25 yrs. @ 5 percent	$ 60.95		
$1.50/a/yr.—25 yrs. @ 5 percent	71.60		
Cost value	$132.55		$132.55
Timber—"yield value":			
34 cords @ $5	$170.00	48 cords @ $5	240.00
Net wood value	$ 37.45		$107.45

TABLE 2.—COMPARISON OF METHODS OF HANDLING SITE PREPARATION COSTS FOR TAX PURPOSES

Expensing		Capitalizing
Timber value	$15.00	$15.00
Depletion	5.00	5.00
	$10.00	$10.00
Site preparation	5.00	5.00
Profit before taxes	$ 5.00	$ 5.00
Actual profit to stockholders:		25% × 5.00 = $1.25
52 percent of $5	$ 2.60	
Profit before taxes	5.00	
	$ 7.60	5.00
25 percent capital gains ($10)	—2.50	1.25
Net	$ 5.10	$ 3.75
Net difference: $5.10 − $3.75 = $1.35		

In order to set forth some practical means of valuing the investment in land during the 25 year rotation, the compound accumulated interest on an investment in land for this period at 5 percent would be:

Per dollar		$ 2.3863
Acreage at:	$ 5	11.93
Acreage at:	$10	23.86
Acreage at:	$15	35.79
Acreage at:	$20	47.73
Acreage at:	$25	59.66

Thus, in our example above, (Table 1) the net wood value at the end of 25 years would support a land cost of approximately $15 per acre on a break even basis.

How to handle the cost of land treatment or site preparation work comes into the picture at this point because constant, unfavorable changes in our tax structure continue to make the timber growing business less and less attractive. There has been and still is a question from the bookkeeping standpoint as to just how this cost should be handled. In fact, there is a wide diversity of opinion among people engaged in this work as to whether it should be treated as an expense item or capitalized. The Treasury Department, at least, has definitely stated in Rev. Ruling 55-252 that site preparation work should be capitalized. However, there appears to be a considerable savings involved if taxpayers, generally, are permitted to treat this cost as a regular woodlands maintenance item.

To show the tax effects of capitalization versus expensing of site preparation costs, let us assume we have harvested $15 worth of timber having a depletion basis of $5 (Table 2). Let us assume too, that we have had site preparation costs of $5 leaving a net profit, before taxes, of $5 [15—(5+5)]. If the site preparation charge of $5 has been written off as ordinary operating expense, the tax savings would be 52 percent of $5 or $2.60 and there would be a capital gains tax on the harvesting of the timber of 25 percent on the $10 profit or $2.50. Thus, the actual profit to

the stockholders would have been, after taxes, $5.10, comprised of the $5 profit before taxes and a $2.60 tax savings on the expenses deducted, less a long term capital gains tax of $2.50.

If we assume the same set of figures and capitalize the site preparation charge in terms of timber, the stockholders would realize $5 profit before taxes minus a 25 percent capital gains tax against this sum amounting to $1.25 or a net profit from the sale equal to $3.75 which is $1.35 less than the actual profit realized in the other example. As can be seen, the handling of these costs on an expanded basis would become very significant depending on the way they are treated for tax purposes. This difference becomes even more marked when the interest on the capitalized expenses is taken into account. In fact, many paper companies firmly believe that capitalization by the Treasury Department renders site preparation costs uneconomical, although this belief can be refuted.

Many paper companies feel that they do not own enough land to wait for natural seeding, perhaps five or more years, to regenerate their forest lands. Approximately 75 percent of the acreage that is currently being prepared and planted would probably never come into full production without artificial treatment, at least within practical time limits. Again, these lands generally include pond and swamp margins, hammocks, scrub-oak ridges, and the bulk of the so-called pine-hardwood types which are predominantly mixed oaks and sweetgum. Also included in this acreage would be partial stands and seed tree stands of longleaf pine which have not reproduced, and are occupying sites suitable for slash pine.

Additional factors which help justify the cost of site preparation work are:

1. When a treatment that scarifies the land is used, it has been shown that the water holding capacity of the soil is increased appreciably and chances for first planting survival consequently increased. This is a significant factor, especially during years of subnormal rainfall.

2. In ridding a site of most of the competing ground cover, the seedling is provided with a definite advantage during periods when soil moisture becomes a critical factor.

3. The "cultivation effect" given to the soil through a disking type treatment provides the seedling with a growth boost. Actually this advantage would tie in closely with the one of reducing competing ground cover. The nearer woodlands can be brought to an "old field" condition, the better.

4. Chances of having fire damage in the stand for three to five years, depending on the degree of treatment, are greatly reduced.

5. In many instances site treatment permits machine planting on areas that without treatment would have to be hand planted or not planted at all.

6. Through preparation, rotations are shortened by about five years.

It logically appears that the limiting factor in site preparation is the site quality of the land to be treated. Obviously, one can afford to spend more money on sites of 80 feet or better as opposed to sites of 70 feet or lower. It is fortunate that better sites bring higher returns because they are usually more expensive to prepare as they normally support more growing stock, desirable and otherwise. This means then that site quality classification is necessary in gauging the degree of site preparation than can feasibly be applied to any given area.

Forestry in Iceland

From Iceland, an island country lying just below the Arctic Circle and not usually thought of in connection with forestry, come some interesting news items.

Iceland is financing a forest planting program in part through a levy on cigarettes. In 1957 this brought in some one million Icelandic crowns (about $61,000), which was about one-fourth of the forest director's budget.

Centuries ago Iceland had a substantial acreage of birch forest. Cutting and grazing by cattle and sheep, reduced these forests to brush, and also caused an immense amount of soil erosion. Now all of the forest products consumed by Iceland must be imported from abroad at very high prices. It seems logical, therefore, that she is engaged upon what appears to be a rather substantial program of forest planting for a country of only 162,000 people. Last year Iceland produced about one million of forest planting stock and aims to double this number in 1958. Species and origin of seed are especially important for Icelandic conditions. Sitka spruce seed is being imported from Alaska and used successfully.

Last September Iceland put out two special issues of postage stamps featuring forestry. It is an interesting coincidence that last September West Germany, the Saar District, and Liechtenstein also issued forestry postage stamps. *Skogen,* the magazine of the Swedish Forestry Society, has suggested that Sweden ought to do the same in the near future.

The fiftieth anniversary of Iceland's first forestry law was marked last November.

RAYMOND E. MARSH

Better Yields Through Wider Spacing[1]

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FORESTRY PRACTICES will be undertaken to the extent that they are likely to provide adequate returns on the investments required. Careful study of the objectives and the means of attaining them must precede practice. Techniques of reforestation, thinning, and pruning that govern the kind and quality of future crops come under this category and can be assessed by thorough analysis of the results to be expected on the basis of present knowledge. Until recently there was a strong tendency to favor practices leading to slow growth; now the evidence suggests that coniferous wood of high quality can be grown quickly under intensive management.

Although the attributes of wood that together define its "quality" depend largely upon the end uses for which it is harvested, some of the attributes are of general importance. For one, specific gravity is so strongly associated with wood strength and pulp yield that it is considered an excellent indicator of quality. It is unfortunate that the presence of wood of high specific gravity in narrow rings of Douglas-fir and other conifers, has strengthened the conclusion that slow growth is necessarily indicative of wood of high quality. This assumption has been used for many years to justify close spacings in plantations and light rates of thinning. Obviously, from the economic point of view, these are less desirable than wide initial spacings and heavy thinnings that provide early returns and increase the rate of interest earned on invested capital. This paper will examine several elements of wood quality as well as important profit and cost factors, and will show how forest managers should plan now for quick growth *and* high quality. Since Douglas-fir is better known than the other species in the Pacific Northwest, discussions will be based on that species but could be extended to other conifers.

Suggested Limits for Rate of Growth

Limits to the rate of growth for Douglas-fir have been suggested by wood technologists. Fleisher (*11*) concluded that the maximum acceptable rate for Douglas-fir veneer was between 10 and 12 rings per inch. Alexander (*1*) said that for use in heavy construction and for high pulp yields per unit of wood volume, second growth Douglas-fir should have 6 or more rings per inch. Paul (*22*) advocated dense stocking to produce wood of high density and strength, and veneer of the best quality.

Premiums for Quality

In order to choose most effectively among the attainable rates of growth, we should recognize the attributes of wood quality which command a premium.

Larger logs cost less to manufacture and usually produce products of higher quality. In general, only one-half as much will be paid per unit for 6-inch logs as for 12-inch logs.

On the Vancouver log market in September, 1957, the combination of large size and clear wood resulted in a premium of 45 to 50 dollars for No. 1 Douglas-fir peeler logs in comparison with No. 3 sawlogs.

Usually, the prices paid for clear-wood products are two or more times those for knotty wood (*24, 25*).

Since British Columbia log and lumber grading rules impose limitation on knot size and on slope of grain, and require straight material, small indirect premiums are paid for these elements of quality.

There seems to be no evidence, however, of premiums being paid directly for wood having unusually high specific gravity or long fibers, except as they are reflected in differing prices paid for the various species. Dense grades of lumber command a small and indirect premium for high specific gravity. Perhaps the difficulties of assessing these attributes of log quality are responsible for this situation.

The most stringent limitations on growth rate of Douglas-fir are those applied in grading for select structural lumber and the better grades of flooring, door stock, rough clear, and specialty products.

Mr. L. B. Dixon, Chief Inspector of the B.C. Lumber Manufacturers Association, has roughly estimated[2] that only 2.5 or 3 percent of all shipments of Douglas-fir from the British Columbia coast are sold under specifications requiring close grain. Close grain refers to a maximum growth rate of 6 rings per inch or 5 rings per inch with more than one third summerwood. The premium paid for Select Structural (Stress) over Select Merchantable (Non Stress) is about $7.50 per M bd. ft. of lumber.

Influences of Rate of Growth on Wood Quality

Turnbull (*27*) challenged the concept that greatest strength was necessarily associated with moderate rates of growth. He found that wood of exotic pines grown in South Africa with wide annual rings was as heavy and as strong as that with narrow rings of the same age. Drawing on this work and Craib's (*6*), Hiley (*15*) argued for heavier thinning of Douglas-fir and other conifers grown in Great Britain.

Rendle and Phillips (*23*) supported Turnbull's conclusions with data on Douglas-fir grown in Great Britain with spacings between 17 and 22 feet and growth rates be-

[1]Research Paper 19. Faculty of Forestry, the University of British Columbia.

[2]Personal communication, October 4, 1957.

tween 3 and 6 rings per inch. Wood at 20 to 40 rings from the pith was found to be invariably heavier than wood of the same growth rate taken within 3 to 15 rings from the pith. For Douglas-fir no important relationship between ring width and density was evident. The fastest tree had an average wood density of 0.494 in comparison with 0.464 for the slowest. In this case a volume advantage of 94 percent was accompanied by an increase of some 6 percent in density.

Large knot size has long been considered a detrimental result of wide spacing. Yet Eversole (*9*) found that at a 12 × 12 foot spacing the average size of the two largest limbs in the whorls immediately above and below breast height on 29-year-old Douglas-fir was only 0.73 inches. We should note that these branches were dead at the time of measurement; furthermore such knot sizes are acceptable even for the manufacture of veneer.

It is encouraging to have evidence that, in the respects just discussed for Douglas-fir, fast growth does not necessarily lead to low wood quality. The possibility that fast growth may lead to shorter fibers and larger fibril angles should not be granted much weight until such time that definite and large premiums can be secured for wood possessing optimum levels of these variables.

Usual Rates of Growth

Sudden and extreme changes in rate of growth are to be avoided, but there seems to be no general use for which a constant rate of growth is essential. This is fortunate since a truly constant rate of growth is almost impossible to achieve.

Table 27 of McArdle, Meyer, and Bruce (*19*) may be used to show that after 20 years of age almost all *fully stocked* stands of Douglas-fir grow at rates equivalent to 7 or more rings per inch. Only a small fraction of the trees in fully stocked stands on ordinary sites could be grown at rates so fast as to cause concern to ordinary users of Douglas-fir. Even the best 100 trees per acre grown on a good site with frequent thinning grew slowly after 30 years of age (*3*).

Improvement of Wood Quality

Having considered objectives suggested by wood technologists, premiums for quality, and usual rates of growth, we should next assess techniques available for the control of wood quality. For naturally established stands, cleaning and weeding may have some effect but thinning and pruning will be most important. Additional techniques available for stands established through planting or seeding include the selection or breeding of improved strains and the use of optimum initial spacing.

It must be presumed that intensive forestry will be practised first on the best and the most accessible lands, and that the silviculturist must work within the limitations imposed by the quality of available sites and the natural growth behavior of the species involved. Little control can be exercised over the most important variable, site quality.

The importance of both site and merchantable diameter are evident in the following example. In a 60-year rotation, land of site index 200 will yield nearly four times the *total* cubic-foot volume of Douglas-fir that can be produced by land of site index 80. Site 200 will produce 5.3 times the volume in trees 7 inches and larger, and 39 times the volume of wood, in trees 12 inches and larger, that can be grown on site 80.

Selection and Breeding

Because trees grown on short rotations will have a relatively large proportion of juvenile wood, individuals that can add wood of high quality at an early age will be particularly valuable. Superior trees should be selected and the biggest and healthiest of their offspring established carefully. Potential gains that may be made through tree selection are immense. Analysis of frequency distributions of Douglas-fir stands will show that, for any given average stand diameter, individual tree diameters may range from 0.1 to 2 times the average. Although age, site, and spacing may be confounded in such analyses, it is probable that some of the largest trees outgrew their competitors because of an inherent capacity to make superior use of their environment. It is essential that such trees be located and used if they rank sufficiently high in the scale of both internal and external attributes of quality.

Selection for high specific gravity, long fibers, and other desirable wood properties is difficult but so worthwhile that it must not be neglected. The advantages of breeding trees with denser wood and more rapid growth have been well illustrated by Mitchell (*20*), who showed than an increase of ⅓ in growth rate *combined* with an increase of ⅓ in specific gravity could nearly double the yield of kraft pulp per acre of southern pine. Similar improvements and a corresponding reduction in cost per unit of pulp are possible for Douglas-fir.

Within natural stands of Douglas-fir on the same site, tree quality varies widely. Data from Littleford (*17*) indicate that average specific gravity of a sample of eight Douglas-fir trees ranged from 0.40 to 0.60. The densest of these trees had about 55 percent summerwood and its wood strength was more than 50 percent above the average for the species. One Douglas-fir tree from the University Research Forest at Haney has averaged nearly 50 percent summerwood while growing at the rate of 4 rings per inch throughout the past 80 years. Another growing nearby averaged only 25 percent summerwood while growing at the same rate for the same number of years. A cubic foot of wood from the first tree could produce as much as 50 percent more pulp and would have strength characteristics superior to those of the second tree. Data for Douglas-fir collected on the University Forest reveal greater variation in wood quality among trees on a

given site than between averages for sites 90 and 160.

In choosing the type of tree to be propagated we should not confuse isolated or open-grown trees with the fast-grown trees that can be produced under intensive management.

Although variations in external attributes of tree quality, such as degree of natural pruning, branch size and angle, and form and taper of bole are worthy of consideration, they are not as important as growth rate and specific gravity.

There is abundant evidence to suggest that improved offspring can be developed by both careful selection and breeding. Surely efforts to improve trees before establishment will be much more rewarding than complete reliance upon the degree of control that is possible through thinning after a stand has been established.

Thinning

Stands should be thinned only if surplus trees can be marketed at an immediate profit or removed at a loss small enough that increased growth in value can repay the investment, carried at an acceptable rate of interest.

Until present supplies of mature and overmature wood are completely allocated, there will be little incentive for thinning. As long as sufficient wood can be secured more cheaply and directly through improved utilization, by going farther up coast, higher in the mountains, into the Interior, or into stands of currently nonmerchantable species, there will be few large-scale thinning programs. Yet the time will come in much of British Columbia, and has actually arrived for some private owners of forest land on the east side of Vancouver Island, when "surplus" trees can be thinned profitably from young stands. Even now it may actually be more economical to use small wood grown close to a manufacturing center than to harvest distant mature stands (*18*).

One thing is certain: We have almost no market comparable to that for the very small wood that can be harvested in Europe.

Carefully planned thinnings of natural stands can capture some of the premiums resulting from selection of trees for the most favorable combinations of size, degree of natural pruning, and growth rate (*13, 28*).

Heiberg (*12*) and, more recently, Braathe (*4*) have reviewed European literature on thinning. Kind, intensity, and frequency of thinning have been discussed from many points of view.

Hiley (*15*), influenced strongly by Craib (*6*), enthusiastically advocated heavy numerical thinning. Hiley aptly suggested that application of the "wait and see" principle of thinning may be regarded as a tiresome punishment for those who neglect their early thinnings rather than a praiseworthy technique of management.

More recently, Hiley (*16*) summarized South African experience and stated that the application of heavy numerical thinnings can halve the cost of wood production.

Möller (*21*) concluded that, within broad limits, *total* yield of trees 2.75 inches at breast height was not influenced by thinning intensity. From this, we may draw the conclusion that when the merchantable diameter limit is greater than 2.75 inches, degree of thinning influences yield. Then highest values will come from those techniques that produce most rapidly the greatest number of trees larger than the minimum merchantable diameter. Such techniques include establishment of fast-growing stock, use of initially wide spacings, and application of relatively heavy thinnings.

Suggested Thinning Schedules

Thinning must leave the best trees and the right number of trees well distributed throughout the area involved.

At least two thinning schedules have been prepared to grow Douglas-fir at specified rates of growth. Heiberg and Haddock (*13*) have planned for rates of growth varying between 7.8 and 6.0 rings per radial inch of the average stand diameter. Hiley (*14*) constructed a yield table for rate of thinning a little heavier than usual British practice. He would change the usual growth rate for 26 to 50 years from 9 annual rings per inch of radius to not less than 6.6 rings per inch on the 100 largest trees per acre. Hiley allowed 5 rings per inch up to 25 years of age. Both of these schedules are presented for ages 28 to 30 in Table 1, together with the schedule used in British thinning practice (*3*) and for Eversole's widest spacing class.

Heiberg and Haddock (*13*) have suggested a schedule that may have advantages in reducing the stocking of a very dense natural stand or where small trees can be harvested profitably. On the other hand, their suggested growth rates are slower than are necessary to grow wood of high quality. Also, by removing 54 percent of the total number and all of the largest trees in the first four thinnings, they could seriously degrade the growth potential of their stands. Barnes' (*3*) data are those of conventional British practice, yet Douglas-fir grown at the slightly faster rates suggested by Hiley (*14*) should still meet our most stringent limitations of growth rate, those required for

TABLE 1.—INFLUENCES OF SPACING AND THINNING SCHEDULES ON GROWTH OF DOUGLAS-FIR

Source	Eversole (*9*)	Hiley (*14*)	Barnes (*3*)	Heiberg & Haddock (*13*)
Tree age, years	29	30	30	28
Site index, feet at 100 years	110	140	140	150
Ave. ht., ft.	46	64	64	60
Ave. d.b.h., in.	7.2	9.6	9.3	6.0
No. trees per acre	287	330	360	735
Vol. per acre, cu. ft.	1,740	4,025	4,170	3,024
Ave. spacing, ft.	12.3	11.5	11.0	7.7

"close grain." Hiley showed that his schedule would increase the rate of interest earned by 0.3 percent from 6.1 to 6.4 percent on site 140. He has shown also that his schedule will produce wood costing only 60 percent that of the usual practice reported by Barnes. Even Barnes' (*3*) schedule should grow cheaper wood than that grown in plantations on the kind of schedule suggested by Heiberg and Haddock (*13*). We should note that the use of initially wide spacings on site 110 has produced a stand with greater volume per tree than in those grown at close spacings on site 150.

Pruning

In spite of technological advances that make more effective use of wood fibers and particles, and of small and knotty trees, the demand for clear wood is likely to continue.

With Douglas-fir, which prunes itself only slowly and very poorly even in plantations with initial spacings of 4 × 4 feet (*9*), early and decisive action must be taken in order to produce any appreciable amount of clear wood. The most effective technique for developing clear wood is artificial pruning. The number of trees that should be pruned will depend upon potential markets, initial spacing, survival, and the thinning regime used. Investment in pruning can be shown to be highly attractive from financial and economic points of view (*25*).

Where growth rates must be limited, as for veneer, restrictions should be imposed after a fast-grown core has been produced, not before, as is the usual practice.

Recent studies of the quality of veneer that can be manufactured from Douglas-fir trees pruned when they were quite young are very encouraging. Fleisher's (*11*) conclusions based on non-pruned and presumably knotty Douglas-fir should be re-examined. Dimock (*8*) reported production of grade "A" face veneer from artificially pruned Douglas-fir grown as fast as 7 rings per inch. The only tree that yielded "A" grade in Fensom's study of pruned trees, grown at rates from 5 to 7 rings per inch, had grown at the rate of 5 rings per inch for the past 26 years (*10*).

With moderately high pruning and relatively short rotations, branch size should not be important, even on widely spaced trees. Eversole's data showed that more than ⅔ of the increase in branch size is associated with increase in d.b.h.

The fact that branches were dead to a height considerably above breast height in a 29-year-old stand spaced 12 × 12 feet on land of site index 110 deserves particular emphasis. Eversole has provided excellent evidence that wide spacing does not result in the large and persistent branches which characterize open-grown trees. His study lends further support to the idea that use of close spacing to control branch development is a very uneconomical way of obtaining clear wood. Even if an early-pruning strain can be selected, it is likely that the delay required to achieve natural pruning could not be justified economically.

Initial Spacings and Thinning Regimes

An interesting trend is evident in planting on the Coast of British Columbia. Since the high of 931 trees planted per acre in 1950, numbers have decreased to an average of 456 in 1956. Trees planted by industry averaged 393 per acre and those planted by the government averaged 567 per acre in 1956 (*5*). There seems to be a growing appreciation of the advantages of wider spacing and, in the light of arguments presented here, this practice is a move in the right direction.

The influence of increasing the planting distance is similar to that of using land of higher site quality. Eversole (*9*), reporting on Douglas-fir grown at several spacings on site 110, showed that at 29 years of age the total cubic-foot volume in trees 6.6 inches and larger was 8 times more for 8 × 8 foot spacing than for 4 × 4 foot spacing. In turn, the volume at 12 × 12 foot spacing was 3.3 times greater than that for 8 × 8 foot spacing.

Cromer and Pawsey (*7*) have presented data to support their conclusion that in order to obtain the maximum mean d.b.h. on the smallest number of trees, the widest possible spacing must be used. They suggest that maximum spacing will be set largely by tree conditions such as straightness, branching habits, and freedom from defects, and by the pruning practices adopted.

We need not examine many natural stands of Douglas-fir to see that the relatively free-growing trees are bigger and healthier than individuals which have endured moderate to severe competition. Since fast-growing trees often possess above-average vigor and, consequently, higher resistance to most hazards, we may expect that risk of loss will be reduced when space per tree is increased. Data from Eversole (*9*) show that the percentage survival of Douglas-fir is much higher at wide than at narrow spacings.

Moreover, the costs of all thinnings and the harvest cut will be less in a stand which has been established with initially wide spacing.

The final decision as to initial spacings will depend largely upon the needs for raw material. If a landowner must produce a maximum total volume of wood, he will choose close spacing. If he is concerned with maximizing the rate of return on his investment as well as his total income, he will choose a spacing much wider than that of so-called fully stocked stands. The number of trees planted per acre and the average distance between them will them will also depend upon the cost of planting, the expected rate of survival, the uniformity of stock, the maximum growth rate permissible, and the required size of tree for the use intended. The initial diameter at which trees can be harvested prof-

TABLE 2.—NUMBER OF TREES PER ACRE BY SPACING AND D.B.H. CLASSES

Average d.b.h.	Ratio of spacing distance in feet to average d.b.h. in inches					
	1		1.5		2	
	Required	Surplus	Required	Surplus	Required	Surplus
	Number of trees per acre					
8	681	245	302	108	170	61
10	436	134	194	60	109	33
12	302	80	134	36	76	21
14	222	52	98	22	55	13
16	170	---	76	---	42	---

itably will be just as important as the rate of interest earned by the investment.

Smith and Walters (*26*) have shown that the per-acre cost of planting Douglas-fir at 6 × 6 feet may be $42.50 in comparison with $12.00 for 12 × 12 feet. Early survival should average at least 85 percent regardless of spacing, but subsequent mortality will be greater in closely spaced stands. Ordinary Douglas-fir planting stock will produce reasonably well-formed trees and, although there is much room for improvement, its shape and form of growth should not be as limiting as that of the Radiata pine reported by Cromer and Pawsey (*7*). For most intensively managed crops of the future, trees of 16 inches d.b.h. at harvest should be acceptable. Trees eight inches in d.b.h. are likely to remain, for many years to come, the smallest that can be harvested at a profit in British Columbia.

If possible, the spacing index should be related directly to rings per inch as illustrated by Hiley (*14*) with the numbers of trees per acre for sites 140 and 155.

We can form some impressions of desired initial spacings by examining yield tables for Douglas-fir.

Expressing average square-spacings as ratios of d.b.h. for Eversole's study on site 110, we have a ratio of 1.36 for the 3.6-inch trees, 1.61 for 6.4-inch trees, and 1.71 for 7.2-inch trees.

A maximum ratio of spacing-to-d.b.h. will occur where trees grow without competition from their neighbors. The crown width in feet of such open-grown trees is not likely to exceed 2.5 times their d.b.h. in inches, therefore we may set the average maximum ratio of square spacing-to-d.b.h. at 2. At spacings greater than twice average d.b.h. total volume production will almost certainly be sacrificed.

The number of trees per acre associated with various ratios of spacing distance to average d.b.h. may be judged from Table 2. The number of trees required to maintain a given ratio of spacing-to-d.b.h. comes from division of the square-foot area of an acre by the square of average d.b.h. times that spacing ratio. Spacing in feet will equal d.b.h. times spacing ratio.

There may be no need to retain the same ratio of spacing to average d.b.h. throughout the life of a stand and, in fact, it probably should be reduced as crowns lengthen with increased height and age.

The potential role of thinning is well illustrated in Table 2: The numbers of trees per acre listed as required for each class must be reduced continually to retain the same opportunity for growth of individual trees. Unless the surplus is reduced by thinning or by natural mortality, rates of growth in diameter will diminish.

With initially wide spacings and thinning at each 4-inch increase in average diameter, only two thinnings need be scheduled to grow trees to 16 inches in d.b.h. With good stock, row-thinnings could be used.

A stem with a d.b.h. of 16 inches, could be grown in 32 years at 4 rings per radial inch, in 48 years at 6, and in 64 years at 8 rings per inch. From 4 to 6 years, including 1 to 2 spent in the nursery, must be added to these numbers to allow for growth of a plantation to breast height.

The average rate of growth of a stand is controlled primarily by site quality. According to Barnes' (*2*) yield table for Douglas-fir, no trees in a well-stocked stand can be grown to 16 inches in average diameter on site 110 at a rate faster than 6 rings per radial inch. Even on site 140 only five percent of the trees will average less than 6 rings per inch. The average number of rings per inch of 6-inch trees grown on site 110 would be 12; 16-inch trees would average 14 rings per inch.

In order to attain the same ring widths on good sites as on poor sites, the number of trees per acre at any given average height cannot be the same on all sites (*14*). On poor sites wide spacings or heavy thinnings will be required to accelerate growth. On sites 100 or poorer, it may even be necessary to isolate the Douglas-fir trees to the point that the stand should be underplanted and managed as a two-storied high forest. These remarks suggest that we should use spacing distances of 1 × d.b.h. on sites 200, 1.5 × d.b.h. on sites 150, and 2 × d.b.h. on sites 100.

Development of optimum spacing must be done gradually in excessively dense natural stands. To avoid excessively fast growth, and to make good use of our sites, we should not plant fewer than 200 Douglas-fir trees per acre. The initial spacing that should be developed in plantations or in natural stands will depend largely on the *average* d.b.h. at which we expect to harvest trees *profitably* as thinnings. We should, therefore, plant or thin to the number of trees corresponding with that d.b.h. and the spacing ratio suggested as pertinent to our site until more refined prescriptions become available.

Concluding Discussion

In the past, immense resources of valuable conifers have given British Columbians a substantial advantage in world markets. This advantage is being reduced steadily by increasing costs of transportation and labor and by competition from home-grown wood in the principal markets for British Columbia products. Because so

much of our forest will be reproduced naturally and will be grown on relatively poor sites, we will continue to develop a large surplus of slowly grown wood. To sustain our position in world markets we must grow large trees of high quality as economically as possible.

We have little experience to to guide us because intensive forestry is actually seldom practised, even in the most accessible parts of the Coast Douglas-fir region of British Columbia, and only to a limited extent in the western United States.

The arguments offered here should stimulate a thorough reassessment of current policies. Techniques that can double the profit in forestry must not be neglected. Further research is required to confirm the absolute importance of site quality, initial spacing, thinning regime, and inherited qualities. However, the following conclusions seem to be logical.

On our best and most accessible sites, we should grow the species and the quality of wood that will bring us the greatest revenues. For much of Coastal British Columbia, this will mean Douglas-fir trees grown at rates of 4 to 6 rings per radial inch. On the basis of current premiums and costs, quick production of clear wood and of large trees will be most rewarding. Since it is likely that dense wood with long fibers will soon command larger premiums, these variables should be emphasised during selection or breeding.

We can achieve quick growth by using relatively few trees per acre at wide spacings. Good seed, or seedlings selected or bred to ensure high quality, should be established carefully on well prepared ground. Reforestation should quickly follow logging. Clear wood should be produced through early pruning of select trees to 19 feet and later pruning to 36 feet in most stands. Heavy numerical thinnings should be applied to maintain growth rates at the maximum level consistant with the use intended.

It is essential that we follow follow these practices *now* to ensure quick growth *and* high quality in the trees of the future.

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Water Relations and Growth Of Trees[1]

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DURING THE LAST several years droughts in New England have been responsible for much reduced growth of trees, poor fruit development, early leaf fall, dieback, thin foliage, transplanting failures, sunscorch, and death of trees (*35*). These effects of drought are by no means restricted to this region and conditions which produce them are of concern wherever trees are grown. For example, in the South summer droughts from two to six or more weeks long are reported to be fairly common (*41*) and in Ohio critically low levels of soil moisture have been reported by the middle of summer (*11*). During such droughts the moisture content of soil may remain close to the wilting percentage, or even slightly below it, for several days or weeks. For example, Fritts (*10*) found that soil moisture on one site in Ohio stayed below the wilting percentage from mid-July to mid-August. Thus soil moisture deficits occur widely and often become critical at the time of year when other factors such as light and temperature are at levels that are extremely favorable for growth.

All changes in tree growth are really a reflection of the speeding up or slowing down of important physiological processes which are influenced to a large degree by the environment. The importance of water relations to trees cannot be overemphasized because in many climatic zones water undoubtedly controls growth more than any other factor. Only rarely are soil moisture supplies at optimal levels during the growing season and tremendous losses in growth result each year because soil moisture deficits cause decreased rates of important physiological processes. The staggering amounts of such losses usually are not realized because data are not available to show how much more growth would occur if trees had favorable water supplies throughout the whole growing season.

Perhaps it is well to reemphasize that growth of trees is conditioned by an exceedingly complex environment and that water is but one factor in this environment. The component factors of the environment are interrelated, interacting, and reciprocal in their effects on growth (*3, 23*). However, extremes in individual factors also are important and growth is influenced by a severe deficiency of one factor though others remain at optimal levels. Taylor (*49*) has further emphasized that growth depends on the amount of a factor available in minimum quantity during the most critical season of the year, or during the most critical year or years.

Development of Water Deficits

Practically all of the water which is absorbed by the roots is subsequently lost in transpiration, primarily through the stomates. Small amounts are lost through the epidermal layers of leaves but this amount varies with the thickness of the cutin layer on leaves, and very small amounts are lost through lenticels of twigs, even from deciduous trees in winter (*21, 53*). The total leaf surface of trees in stands makes up a large evaporating surface which depletes soil moisture rapidly. In the South forests are estimated to lose up to 8,000 gallons of water an acre each day. In Europe forest stands have been estimated to transpire between 200 and 850 tons of water per acre each year (*40*). Cummings (*6*) estimated that one open-grown silver maple tree which was 47 feet high had 177,000 leaves with a combined leaf blade area of a sixth of an acre. This tree was estimated to lose water at the rate of 58 gallons per hour during the late afternoon in July. These large losses are unavoidable because water tends to evaporate from leaves through stomates under conditions of low humidity, high temperature, and high light intensity.

Large diurnal variations occur in transpiration rates. The rate increases during the morning hours, begins to decrease in the late afternoon, and practically stops during the night. Seasonal variations occur also and transpiration appears to increase as leaves unfold, reaches a maximum at the time the greatest leaf area is attained, decreases slowly as leaves become senescent, and finally decreases very rapidly as leaves begin to abscise (*28*).

Water contents of leaves vary diurnally, with the highest water contents occurring in the early morning. Leaf moisture contents decrease throughout the morning, reach a minimum sometime in the early afternoon, and then begin to increase sometime in the late afternoon. Moisture contents of tree trunks also vary diurnally and seasonally. Tree trunks usually undergo slight shrinkage in the afternoon even in well watered soils, because of stem dehydration. During the night trees tend to fill up with water so their diameters increase. Seasonal changes in moisture content occur also. In general, tree trunks have the highest water contents in the spring, sometime around the beginning of bud break. When the leaves emerge transpiration begins and tends to deplete the stem of water throughout the summer until a minimum moisture content is reached just before leaf abscission (*13*). Conifer stems also show seasonal variation in moisture content, but they fluctuate less than hardwoods (*12*). Seasonal shrink-

[1]Paper presented at the meeting of the Massachusetts Tree Wardens and Foresters Association, Boston, Mass., Feb. 5, 1958.

age and swelling of tree trunks often result from changes in their water contents (*15*). The amount of shrinkage seems to vary with the type of wood and is reported to be greater in softwoods than hardwoods (*8*). The diurnal and seasonal changes in moisture contents of leaves and stems result primarily because absorption of water lags behind transpirational loss. According to Kramer (*25, 27*) the absorption lag occurs largely because there is considerable resistance to water movement across the root cells. There also appears to be some resistance to water movement in leaf cells.

Transpiration is considered by many plant physiologists to be an unavoidable evil because it results in much water loss and wilting of leaves. Temporary wilting occurs often in the afternoon even when soil moisture supplies are plentiful. Physiological processes such as photosynthesis are checked temporarily by such wilting but leaves usually recover turgidity at night so temporary inhibition of physiological processes is not a serious matter. However, wilting becomes very serious when soils begin to dry out, because leaves are less likely to recover turgidity at night. Under conditions of prolonged drought leaves become desiccated and may eventually scorch. In 1948 entire streets of maples in Boston turned brown and shed their leaves because of an unfavorable internal water balance (*36*). This probably was the result of inability of water absorption to keep up with transpiration. Considerable winter and early spring injury also occurs in conifers because of desiccation of leaves. The air may warm up sufficiently during winter or spring days to increase transpiration. Since the soil is cold or frozen, the water cannot be absorbed rapidly (*21*) and leaves dry out. Voigt (*52*) described such injury to several conifers in Wisconsin. The injury was confined to parts of trees which were most exposed to warm southerly winds and subject to high transpiration. Curry and Church (*7*) also noted such injury to conifers during the same winter over extensive areas of the Adirondacks. Entire mountainsides were covered with discolored trees.

When internal moisture stresses develop in trees because of transpirational loss, there is considerable internal competition for water, often between leaves and fruits. Lemons, oranges, and pears have been observed to decrease in diameter in the daytime and to increase in diameter during the night (*2, 16, 47*). As leaves dry out in the middle of the day because of high transpiration rates they develop very high diffusion pressure deficits and water therefore moves along an osmotic gradient from fruits to the leaves. As mentioned earlier, leaves tend to fill up with water at night and, as their diffusion pressure deficits decrease, they no longer can extract water from the fruits. At night the fruits also tend to fill with water so their diameters increase. There also is internal competition for water between different leaves and branches.

Effects of Water Deficits on Growth

It is well known that drought checks growth of trees (*22, 27*). Variations in soil moisture supply influence growth in some regions much more than in others. For example, in the pine forests of northern Arizona water supply is considered the most important environmental factor for growth. There trees rarely get all the water they can use because there is variation in the amounts of rainfall from year to year and because only a small amount falls each year (*14*). In such arid regions a few more inches of rainfall may more than double the amount of water actually absorbed by or available to the trees. In regions of high rainfall, however, a few additional inches of rain usually do not affect growth significantly (*37*).

Growth is decreased when internal water deficits prevail because of decreased availability of carbohydrates, decreased enlargement of cells, and earlier cell differentiation. In general, variations in soil moisture supply during the growing season affect diameter growth more than height growth. It has generally been held that height growth of many trees is made at the expense of stored carbohydrates rather than products of current photosynthesis (*29, 24*). Height growth of many deciduous trees starts early in the season and much of it is completed long before the crown is producing carbohydrates at its maximum rate for the season. In Connecticut, Kienholz (*19*) reported that height growth of a number of species lasted only about 60 days and was completed by the end of June. An unusually short growing season was cited by Johnston (*18*) who found that in Missouri three species of oak completed practically all seasonal height growth in only 19 days, and made 90 percent of it in only 11 days in late April and May. Although most trees have longer growing seasons than this, in general they complete all their height growth relatively early in the season and often long before the droughts of mid-and late summer occur. In many conifers height growth appears to be better related to rainfall of the previous season than to current rainfall because in most conifers shoots are morphologically determined in the bud laid down in the previous year. Therefore current height growth represents expansion of the bud and does not involve growth of new organs (*48*). Often the amount of current height growth can be correlated with the size of the bud which is influenced by environmental conditions prevailing at the time the bud was formed. However, there are some studies which show positive correlations between height growth and current precipitation on dry sites (*20, 44*). Pearson found that in northern Arizona western yellow (ponderosa) pine trees depended largely on rain stored during the previous winter and spring for height growth. If winter rain provided the only supply of water, small amounts of shoot growth occurred.

But if April and May rains supplemented winter rainfall, the amount of height growth was much greater. This situation is very different from that of other regions, and Pearson pointed out that there probably are sites within the range of western yellow pine on which rainfall does not affect height growth.

Diameter growth usually begins later in the season and lasts longer than height growth. In fact in some species diameter growth near the base of the tree does not begin until the peak of height growth is over. For example, Reimer (*46*) reported that Norway maple and sugar maple completed height growth in Indiana before the end of May, but diameter growth of these species did not begin until after the first week in June and then continued into August. Diameter growth probably depends largely on products of current photosynthesis and therefore is quite sensitive to variations in water supply during the growing season (*10, 31, 32, 39, 50, 51*). Diameter growth often stops during a drought and resumes after a rain. MacDougal (*33*) found that a Monterey pine which stopped growing in midsummer responded to irrigation and put on more wood than it did early in the season.

Tryon, Cantrell, and Carvell (*50*) reported that in West Virginia rainfall during the early part of the growing season influenced height growth of yellow-poplar but its diameter growth was considerably more responsive to water supply than was height growth. Hustich (*17*) believes that in areas where water is abundant in the spring, height growth is controlled largely by weather of the previous growing season. However, in areas of low spring rainfall height growth can be better correlated with current year rainfall. In areas with adequate moisture supply in the spring, late summer droughts do not influence current height growth of trees which complete shoot elongation before midsummer, a very common occurrence in New England.

Photosynthesis and Water Supply

Since carbohydrate supplies are ultimately converted into plant tissues the relation between water supply and photosynthesis is of foremost importance in tree growth. Water deficits in leaves may reduce photosynthesis directly by reducing the moisture content of the photosynthetically active mesophyll cells of the leaves and indirectly by causing closing of stomates and impeding the entry of carbon dioxide into leaves. Stomatal closure occurs earlier in the day for plants in dry soil than in plants growing in well watered soil (*26*). Magness, Degman, and Furr (*34*) found stomatal closure to be an excellent index of water deficits in apple trees.

Photosynthesis in trees decreases as soils dry down (*4, 22, 42*) and there is evidence that the reduction takes place in drying soils before noticeable wilting of leaves occurs. Allmendinger, Kenworthy, and Overholser (*1*) found that in drying soil photosynthesis of apple trees declined as much as a week before wilting occurred. Loustalot (*30*) emphasized that once photosynthesis was depressed by a severe drought, reirrigating the soil to field capacity did not cause an immediate increase in photosynthesis. In fact, ten days after the soil was rewatered photosynthesis recovered to only about two-thirds of the expected rate. Photosynthesis of loblolly pine and sweetgum seedlings decreased greatly in drying soil and the effects were apparent before the wilting percentage of the soil was reached (*4, 22*). These observations emphasize the necessity of turgid leaves with opened stomates for maximum rates of photosynthesis.

If the soil moisture content is considerably above field capacity and the large pores are filled with gravitational water, the rate of photosynthesis may increase somewhat as the soil dries to field capacity. Negisi and Satoo (*42*) observed this in Japanese red pine seedlings. When the soil continued to dry down below field capacity, however, the rate of photosynthesis declined. The increased rate of photosynthesis with drying of soil from above down to field capacity may result from improved soil aeration, increased stomatal opening as turgor is slightly reduced, or both.

Water deficits develop regularly in leaves during the middle of the day and cause decreases in photosynthesis even when the soil is adequately supplied with moisture (*45*). Such midday decreases often are attributed to excessive transpiration resulting in stomatal closure, although other causes such as decrease in carbon dioxide content of the air, carbohydrate accumulation, and photooxidation of enzymes sometimes also are involved. McLean (*38*) reported that photosynthesis decreased greatly during the middle of the day in coconut leaves and that carbon dioxide was given off by the leaves. This indicated that the rate of respiration was greater than the rate of photosynthesis. Such large decreases probably are unusual and other investigators have reported much smaller midday drops in photosynthesis (*43, 45*). Photosynthesis in trees having leaves with thin cuticles is affected less by stomatal closure than in trees with thick cuticles on the leaves. Some leaves are quite permeable to carbon dioxide, as Freeland (*9*) has noted, and will absorb large amounts of carbon dioxide through a non-stomated epidermis. Presumably considerable absorption of carbon dioxide takes place through the leaf epidermis in such species even when their stomates close.

In flooded soils absorption of water by roots often decreases and lags behind transpiration. This causes leaves to dry out and check photosynthesis. Loustalot (*30*) found that flooding of pecan trees growing in sand caused photosynthesis to drop to 11 percent of the normal rate. Flooding of trees growing in heavier soil reduced photosynthesis even more. Reduced photosynthesis was also observed in

apple leaves in 2 to 7 days after flooding (*5*). It appears therefore that photosynthesis can be decreased by too much as well as too little soil moisture.

Summary

1. Reduced growth of trees, early leaf fall, dieback, transplanting failures, sunscorch, and death of trees often occur as a result of an unfavorable internal water balance in trees.

2. Diurnal and seasonal variations in water contents of leaves and stems result primarily because water absorption lags behind transpiration. The absorption lag occurs primarily because of resistance to water movement across root cells.

3. Under prolonged drought leaves do not recover turgidity and become desiccated and scorched in summer. Winter injury also occurs widely when evergreens lose moisture and absorption cannot replace water in the leaves rapidly enough.

4. Growth of trees is checked by moisture deficits. Diameter growth appears to be more sensitive than height growth to variations in soil moisture supply during the growing season.

5. Water deficits in leaves check growth of trees by influencing carbohydrate supplies through direct and indirect effects on photosynthesis.

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SCHOOL BOX SCORE
1958 MEMBERSHIP

	Student Applications Received		
	July 1958	Total 1957	Total 1958
Alabama Polytechnic Institute	0	19	22
University of California	0	30	56
Colorado State University	0	19	13
Duke University	1	13	3
University of Florida	0	6	14
University of Georgia	0	86	39
University of Idaho	1	19	13
Iowa State College	2	35	19
Louisiana Polytechnic Institute	0	18	5
Louisiana State University	0	41	6
University of Maine	0	31	22
University of Massachusetts	0	10	4
Michigan College of M. & T.	0	29	4
Michigan State University	4	24	25
University of Michigan	1	14	14
University of Minnesota	1	28	27
University of Missouri	0	62	7
Montana State University	1	45	16
State University of New York	0	25	12
North Carolina State College	0	36	1
Oregon State College	2	29	27
Pennsylvania State University	0	32	21
Purdue University	0	18	18
Utah State University	0	5	24
University of Washington	1	27	24
West Virginia University	4	19	19
Yale University	1	7	5
Total	19	727	460

SECTION BOX SCORE
1958 MEMBERSHIP

	Applications received[1]		
	July 1958	Total 1957	Total 1958
Allegheny	4	68	46
Appalachian	4	71	16
Central Rocky Mountain	0	24	13
Central States	0	30	19
Columbia River	4	55	45
Gulf States	5	84	34
Inland Empire	1	21	15
Intermountain	0	6	31
Kentucky-Tennessee	0	8	3
New England	2	62	42
New York	0	37	20
Northern California	1	39	11
Northern Rocky Mountain	1	49	22
Ozark	2	921	18
Puget Sound	4	61	44
Southeastern	1	132	84
Southern California	0	3	0
Southwestern	0	7	0
Upper-Mississippi Valley	4	69	54
Washington	0	10	1
Wisconsin-Michigan	7	84	60
Total	40	1,012	578

[1]Student, Junior, Affiliate, Associate (Initial) grades only.

Aspen Debarking With 2,4,5-T

Cherng-jiann Shiue, R. M. Brown, and L. W. Rees[1]

APPLICATION OF CHEMICALS to living trees to extend the peeling season and to make easy peeling is rapidly becoming a new industrial tool for pulpwood operations. Although arsenic compounds have been used as commercial debarking agents, they have serious disadvantages: girdling is necessary requiring more labor and increasing the costs; they are toxic to human beings and wildlife; and the bark does not readily peel below the girdle.

Many investigations, such as those reviewed by Crafts (*1*), have shown that certain kinds of hormone-type chemicals such as 2, 4, 5-T and its derivatives penetrate the intact plant, translocate up and down the stem from the place of application, and have a highly lethal effect on woody plants. Because of the foregoing characteristics and also because they are nontoxic to human beings and animals, they hold considerable promise as debarking agents.

Early experiments with hormone chemicals at the New York State College of Forestry and Michigan State University showed inconsistent results in both lethal effect and bark-peeling ability. Panshin et al. (*5*), Raphael et al. (*6*), Gläser (*3*), and Wilcox et al. (*10*), investigating the use of hormone-type chemicals as debarking agents, obtained unsatisfactory results, and therefore concluded that the hormone-type chemicals could not be recommended as debarking agents. The hormone chemicals that have been used are the amine salt, the ethyl ester, and the isopropyl ester of 2, 4-D and the isopropyl ester and the propylene glycol butyl ether ester of 2, 4, 5-T. On the other hand, MacConnachie (*4*), conducting informal studies, found that a formulation of the butoxyl ethanol ester of 2, 4, 5-T when applied to aspen gave encouraging debarking effects. These conflicting results are no doubt due to the effectiveness of the chemicals used, the response of tree species involved, and the time and place of application of the chemicals. Therefore the objectives of this study were to determine (1) the effectiveness of the butoxyl ethanol ester of 2, 4, 5-T as an aspen (*Populus tremuloides* Michx.) debarking agent, (2) the most effective place of application, (3) the optimum season for treating aspen, and (4) how long after treatment the aspen bark remains peelable.

Tests of the Reliability of the Wilcox Peelability Tool

Wilcox's peelability tool (*9*) was used to determine the force in pounds per square inch necessary to remove the bark. Raphael et al. (*6*) reported wide variation in the results obtained with this tool. In the present investigation, however, fairly consistent results were obtained by modifying the procedure (1) using a knife to cut the bark not completely cut through by the saw, especially on small trees, and (2) equipping the spring scale with a maximum indicator.

In order to establish the relationship between the results obtained by using the peelability tool and the amount of bark removed in a drum debarker, a random sample of pulp sticks cut from treated and untreated aspen was used. The bark peeling resistance of the pulp sticks was measured with the Wilcox tool and the amount of bark removed was measured after the pulp sticks ran through either a portable debarker at the Cloquet Experimental Forest or a commercial drum debarker of the Northwest Paper Company in Cloquet. The amount of bark removed was measured in terms of percentage of clean wood surface based on total surface of the pulp stick. The relationship between the tool reading and the corresponding percentage of bark removed was found to be linear for the range of bark resistance most frequently encountered as shown in Figure 1. The correlation coefficients, -0.703 and and -0.872 for portable and commercial drum debarkers, respectively, are highly significant beyond the 1 percent level, indicating that approximately 50 and 75 percent of the variability of percentage of bark removed is accounted for by this linear trend. Therefore, the tool reading may be used as a debarking index to evaluate the effectiveness of debarking agents. Obviously the commercial drum debarker gave the best results.

Butoxyl Ethanol Ester of 2,4,5-Trichlorophenoxyacetic Acid As An Aspen Debarking Agent

In order to determine the effectiveness of this chemical as a debarking agent, the optimum time of treating, and the most effective place on the tree to apply the chemical, more than 200 aspen trees from 6 to 10 inches in diameter breast high were treated in 1955 at the Cloquet Experimental Forest. Forty trees were treated on each of seven different dates beginning April 15 and continuing throughout the growing season. The chemical was applied either at the base of the tree or at breast height. The treated trees were divided into four groups, each group to be cut in a different month, namely August, September, and October of 1955

[1] The authors are assistant professor and professors, respectively, in the School of Forestry, University of Minnesota. They are indebted to Mr. R. A. Jensen of the Cloquet Experimental Forest, University of Minnesota, and Mr. W. M. MacConnachie of the Northwest Paper Company, Cloquet, Minnesota, for their cooperation in making the drum-debarking study possible. This paper is published as Scientific Journal Series No. 3807 of the Minnesota Agricultural Experiment Station, Institute of Agriculture, St. Paul, Minnesota.

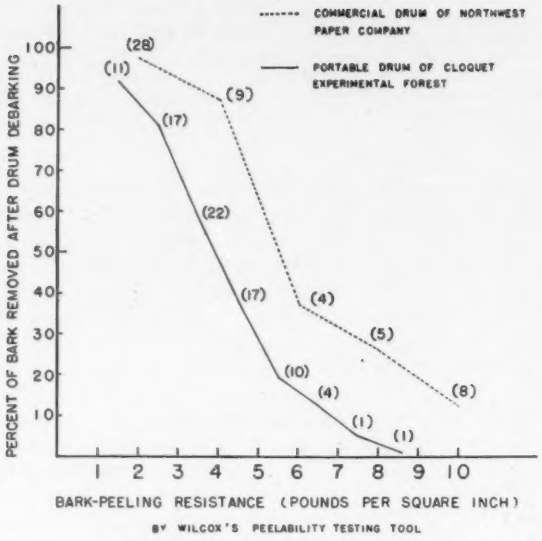
COMMERCIAL DRUM OF NORTHWEST PAPER COMPANY
PORTABLE DRUM OF CLOQUET EXPERIMENTAL FOREST
PERCENT OF BARK REMOVED AFTER DRUM DEBARKING
BARK-PEELING RESISTANCE (POUNDS PER SQUARE INCH)
BY WILCOX'S PEELABILITY TESTING TOOL

FIG. 1.—The relationship of bark-peeling resistance to percentage of bark removed after drum debarking. Figures in parentheses show the number of pulpwood sticks from which the average percentages of bark removed were computed.

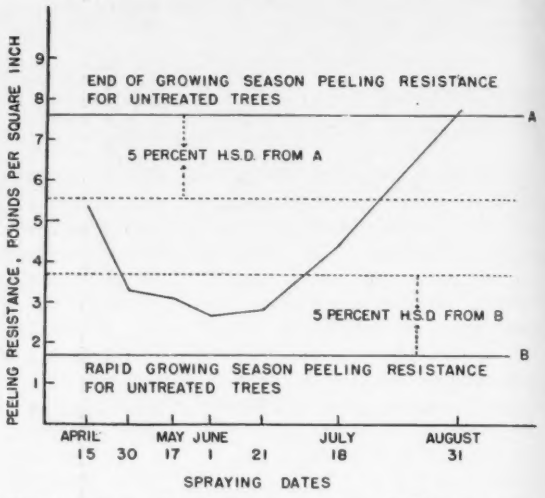
END OF GROWING SEASON PEELING RESISTANCE FOR UNTREATED TREES
5 PERCENT H.S.D. FROM A
5 PERCENT H.S.D. FROM B
RAPID GROWING SEASON PEELING RESISTANCE FOR UNTREATED TREES
PEELING RESISTANCE, POUNDS PER SQUARE INCH
SPRAYING DATES

FIG. 2.—The peeling resistance of trees treated at breast height on different dates throughout the entire growing season and cut in October.

and April of 1956. The chemical was applied at a concentration of 21 pound-acid-equivalent to 100 gallons of diesel oil with a coarse sprayer in a band about 18 inches wide completely around the tree. Each gallon of diluted solution was sufficient to treat 15 to 20 trees, depending on the diameter of trees and the place of application.

The foliage was killed quickly and completely on trees sprayed at breast height in May, June, or July; but little or no foliage was killed on trees treated in the early part or at the end of the growing season. Trees treated in June had the lowest peeling resistance as measured by the Wilcox tool. In Figure 2, line A shows the peeling resistance of untreated trees cut in September, while line B is the peeling resistance in the so-called natural sap-peeling season. The peeling resistance of untreated trees will change from the value at B at the beginning to that at A at the end of the growing season. The peeling resistance of trees treated with 2,4,5-T does not follow this normal change. For example, the peeling resistance of trees sprayed on April 15 increased from 1.75 to 5.35 pounds per square inch, and trees sprayed on April 30, from 1.75 to only 3.30, etc. By comparing this difference with the 5 percent honestly significant difference (hsd) (*2*), the August 31 spraying has no effect on the reduction of peeling resistance. The trees treated on April 30, May 17, June 1, and June 21 retain ease of peeling very close to that of natural sap-peeling.

Inconsistent lethal effects and high peeling resistance were obtained when the chemical was applied to the base of the trees. This appeared to be due to the presence of moss or canker scars which retard the absorption and translocation of the chemical by the tree. Figure 3 shows the growth of a typical layer of moss (*Orthotrichum* spp.) at the base of an aspen. Such a heavy layer of moss absorbs a large amount of chemical and prevents the chemical from entering the tree, causing a poor lethal effect. Figure 4 shows a canker scar (*Nectria* spp.). Since the tissue around the scar is dead, absorption and translocation will not take place in this area. The chemical does not come in contact with the tissues directly above the scar. As a result, a poor lethal effect and high peeling resistance are obtained.

Trees sprayed at breast height in May or June retain their sap-peeling characteristics until the trees are frozen solid. Thawing in the following spring further reduces the peeling resistance of chemically treated trees. Therefore the treated trees can be readily peeled in the fall and the following spring.

Figure 5 shows pulpwood sticks cut from trees with different chemical treatments after they were debarked by the commercial-drum debarker of the Northwest Paper Company at Cloquet. The April 15 basal spraying gave results not significantly different from the untreated trees. The April 30 basal spraying also resulted in a low percentage of bark removed. All the bark was removed from the bolts of trees sprayed at breast height on June 1.

Comparison of the Debarking Effectiveness of Different Chemicals at Different Concentrations

Two commercial formulations of butoxyl ethanol ester of 2,4,5-T, ACP #329, and Weedon-T were tested at concentrations of 16, 21, and 25 pound-acid-equivalent to 100 gallons of diesel oil. The chem-

FIG. 3.—A thick layer of moss (*Orthotrichum* spp.) growing on the base of an aspen introduces considerable variation in the lethal effect of the chemical.

FIG. 4.—Scars caused by canker (*Nectria* spp.) also introduce considerable variation in the lethal effect of the chemical.

ical was applied to the base of trees on April 30, 1955. Trees untreated and treated with sodium arsenite on May 17 served as checks. At the end of the growing season, trees were cut and the bark-peeling resistance measured with the Wilcox tool. Results showed no significant difference in peeling resistance between trees treated with the two types of 2,4,5-T used. Although these chemicals were used at different concentrations, the debarking effects were not significantly different. This may indicate that the range of concentration studied is already beyond the least amount of chemical necessary to kill the trees. Actually the amount of chemical required to kill a tree is rather small and is only a minute fraction of the amount of chemical applied. Therefore the lethal effect is more closely associated with the amount of chemical absorbed rather than the amount of chemical applied.

Trees treated with 2,4,5-T or sodium arsenite had much less peeling resistance than untreated trees. Table 1 gives the average peeling resistance of trees with different treatment.

The difference between 2,4,5-T and sodium arsenite treatment, 0.90 pound per square inch, is not statistically significant. Compared to the check trees, both the 2,4,5-T and sodium arsenite gave highly significant differences. However, the peeling resistance of 2,4,5-T basally treated trees varied considerably. Greater variation in peeling resistance of trees sprayed at the base will give inconsistent results in debarking. Therefore basal spray is not recommended.

In June 1956, additional studies were made to determine the effect of spraying at breast height with and without girdling. Only one concentration, 21 pound-acid-equivalent, was used. Butoxyl ethanol esters of 2,4-D and 2,4,5-T and formulated 2,4,5-T were compared. Trees sprayed with diesel oil served

FIG. 5.—Bark removal from pulpwood sticks cut in October from trees treated differently and run through the commercial drum debarker at the Northwest Paper Company. Each group of three sticks represents one of the following nine treatments. From left to right: 1. Basal spray on April 15. 2. Breast high spray on April 15. 3. Basal spray on April 30. 4. Breast high spray on April 30. 5. Basal spray on May 17. 6. Breast high spray on May 17. 7. Basal spray on June 1. 8. Breast high spray on June 1. 9. Check, no treatment.

as a check. Table 2 shows the results.

The peeling resistance of girdled trees was significantly higher than non-girdled trees when they were treated with 2,4-D and 2,4,5-T. The peeling resistance of trees treated with 2,4,5-T or formulated 2,4,5-T applied to the non-girdled stem at breast height is very close to the resistance in the natural sap-peeling condition. Therefore trees treated by this method can be easily hand-peeled in the woods or drum-debarked in the mill even when they are cut in the dormant season.

TABLE 1.—COMPARISON OF THE AVERAGE PEELING RESISTANCE OF TREES TREATED WITH 2,4,5-T BASAL SPRAY OR SODIUM ARSENITE

Treatment	Number of trees treated	Average peeling resistance
		Pounds per square inch
2,4,5-T	90	3.40[1]
Sodium arsenite	15	2.50
Untreated	15	6.55

[1]Average of all 2,4,5-T treatments, including types of formulation and the three concentrations used.

Significant Changes in the Trees and Wood as the Result of Chemical Debarking with 2,4,5-T

Significant changes occurred in the trees during and following chemical treatment. One of the first noticeable effects was the increase in wood moisture content. Proper 2,4,5-T treatment induced foliage killing within two or three weeks. As a result the function of losing water through transpiration ceased. However, the bark and wood parenchyma responded by having high osmotic pressure (*8*). This increased the diffusion pressure deficit of the tree resulting in more water intake from the soil. The greater water intake and the cessation of transpiration increased the moisture content of both the bark and the wood of the treated trees. However, the 2,4,5-T treatment also reduced the rate of increase in the moisture of the wood during the early fall when compared with untreated trees. When the trees were cut in August and September, the wood of treated trees had a much higher moisture content than that of untreated trees. The average moisture content of untreated trees was 73 percent and treated trees 91 percent. No significant difference in wood moisture content was found between treated and untreated aspen when cut in October and the following spring. The wood moisture content of treated and untreated trees cut in October and the following spring averaged about 110 and 97 percent respectively.

Certain anatomical and color changes and difference in growth of fungi were observed on treated trees. Although the surface of the wood was light brown when the bark was removed from treated trees cut in August and September, it was clean and without any apparent defects. *Armillaria mellea* grew abundantly beneath the bark at the base of treated trees cut in the late fall or the spring of the second year but up to that time no rot appeared.

A major anatomical change in the wood took place after chemical treatment with 2,4,5-T. Numerous tyloses developed in the sapwood of treated aspen. This could reduce penetration of the cooking liquor into the chips and slow down the pulping process.

The sprout producing capacity of the root system was also affected. Within 3 to 4 feet from the stump, the roots showed evidence of killing. However, roots beyond 6 feet from the stump appeared alive and normal externally and internally when the tissues were examined under the microscope. A greenhouse study showed that root cuttings taken at a distance beyond the killed part from treated trees suckered similar to or even better than untreated trees. Since aspen roots may extend 40 or more feet from the stump (*7*), and the damage to the root caused by the 2,4,5-T treatment is limited to only 3 or 4 feet from the stump, the effect of chemical treatment on reproduction of aspen by suckers seems to be negligible. Therefore chemical

TABLE 2.—COMPARISON OF THE BARK PEELING RESISTANCE OF GIRDLED AND NON-GIRDLED TREES SPRAYED AT BREAST HEIGHT WITH DIFFERENT CHEMICALS

Method of application	Chemicals			
	Diesel oil	2,4-D	2,4,5-T	Formulated 2,4,5-T
	Average peeling resistance, pounds per square inch			
Girdled	7.57	6.38	5.07	2.87
Non-girdled	6.85	4.60	2.62	1.97
Difference	0.72	1.78**	2.45**	0.90

**Significance at 1 percent level.

debarking with 2,4,5-T should not prevent aspen from establishing a second crop by sprouting.

Summary

Peeling resistance of aspen cut in the dormant season was significantly reduced by 2,4,5-T. Breast-high spraying was more effective than spraying at the base. June treatments resulted in the least peeling resistance. Bolts from trees sprayed at breast height in June were satisfactorily hand peeled or debarked in a drum debarker even though cut in the dormant season when untreated trees can not be cleanly and economically peeled. Spraying with 2,4,5-T with concentrations of 16, 21, and 25 pound-acid-equivalent to 100 gallons of diesel oil showed similar results in debarking effectiveness. This may indicate that the range of concentrations studied is already beyond the least amount necessary to kill aspen.

Treatments with two forms of 2,4,5-T, Weedon-T, and ACP #329, gave satisfactory bark separation. On the other hand 2,4-D resulted in high-peeling resistance. Since girdling prevented these hormone chemicals from being absorbed and translocated, spraying without girdling is recommended. Treated aspen showed significantly higher moisture in both the bark and wood compared to untreated trees when they were both cut in August and September.

However, in untreated or check trees the moisture content of the wood increased rapidly at the end of the growing season. The chemical treatment retarded this rate of change. Therefore no significant difference in moisture content was found between untreated and treated trees when they were cut in October or the spring of the following year. Tyloses were abundant in the sapwood of treated aspen. This may retard chemical pulping. Debarking of aspen by this hormone chemical did not seriously damage the root system; and for this reason it is not likely to prevent aspen from establishing a second crop by suckering. This evidence indicates that chemically debarking aspen with butoxyl ethanol ester of 2,4,5-T gives promise as a practical and efficient industrial process.

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Earl C. O'Roke (1887-1958)

Earl C. O'Roke of Ann Arbor, Mich., died January 30 at the age of 70. Dr. O'Roke retired in July 1957 as professor of economic zoology at the University of Michigan. He had been a member of the faculty there since 1929.

Dr. O'Roke, who was born in Sabetha, Kan., August 2, 1887, received his B.A. degree in 1912 and his M.A. degree in 1916, both from the University of Kansas. He studied for his Ph.D. at the University of California while working as an assistant and received his doctorate in 1929.

Dr. O'Roke was a member of Sigma Xi and and was a Fellow in the American Association for the Advancement of Science. He joined the Society of American Foresters in 1931.

Ambrosia Beetle Infestation of Coniferous Logs on Clearcuttings in Northwestern Oregon[1]

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AMBROSIA BEETLES are common pests of coniferous and hardwood timber in many parts of the world. They have caused heavy damage to logs and lumber in southern United States and in British Columbia (*1*). Little has been published on their economic importance in western United States. The present exploratory study was made of the frequency and intensity of ambrosia beetle attack in coniferous logs on clearcuttings in northwestern Oregon. Such a study was considered a prerequisite to more detailed investigations on the damage caused by these wood-boring insects. Observations were taken on Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco), western hemlock (*Tsuga heterophylla* [Raf.] Sarg.), grand fir (*Abies grandis* [Dougl.] Lindl.), and western redcedar (*Thuja plicata* Donn).

The Insects

Ambrosia beetles are small, cylindrical, elongated beetles of the families Platypodidae and Scolytidae. They bore directly into the wood of weakened or recently killed trees, fresh logs, and occasionally green lumber (Figs. 1, 2, 3). The tunnels of 1/16-inch diameter or less usually occur in the sapwood of our native conifers—occasionally penetrating the heartwood. The wood borings that are ejected from the tunnels and accumulate in bark crevices are evidence of attack. The beetles carry spores of ambrosia fungus into the tunnels. Here the ambrosia fungus grows and provides food for the beetles. After a period of time, the fungus stains the tunnels black distinguishing the work of ambrosia bettles from other small wood-boring insects.

The ambrosia beetles commonly encountered in the study were: *Trypodendron lineatum* Oliver, *Gnathotrichus sulcatus* LeConte, and *Platypus wilsoni* Swaine. These species are illustrated in Figure 4. *Gnathotrichus retusus* LeConte was found in coniferous logs, but its damage was not distinguished from that of *G. sulcatus*. An occasional attack by *Xyleborus saxeseni* Ratz. was noted in Douglas-fir logs outside the immediate study area.

Economic Importance

The holes of ambrosia beetles can cause serious reduction in lumber grade, but usually the wood is not weakened materially (Fig. 1). McBride (*4*) reports that in British Columbia, hemlock and Douglas-fir sawlogs, after a moderate attack by ambrosia beetles, may suffer losses from $1.20 to $3.31 per thousand board feet. McMullen (*5*), also in Canada, showed that in certain classes of lumber, the presence of ambrosia beetle holes could reduce the value as much as 64 percent and in plywood veneer as much as 36 percent. The lumber grading rules used in the United States (*7*) are similar to those used in Canada: thus, similar losses can be expected if ambrosia holes are present. For example, in a species of lumber that would otherwise grade "B or Btr.," the presence of a single "pinhole" would degrade it to "D" with a loss of over one-third of the value at the retail level.

In addition to the monetary loss from degrade, Graham and Boyes (*2*) report that quarantine laws and public prejudice against lumber showing sign of ambrosia beetle damage have caused lumber manufacturers, especially exporters, serious problems. These same authors point out the hidden costs involved if extra time is spent in

[1]Adapted from the thesis submitted in partial fulfillment of the requirements for the degree of Master of Science, Oregon State College, December 1956

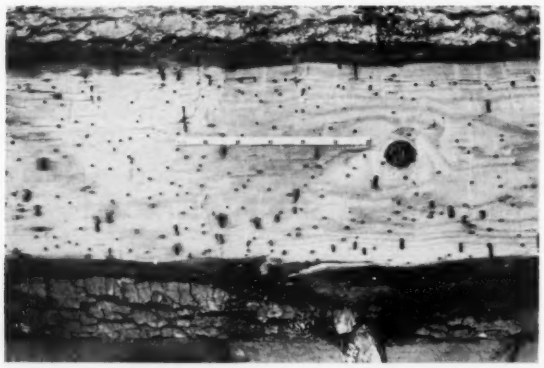

FIG. 1.—A 12-inch Douglas-fir log slabbed to show "pinholes" in sapwood caused by ambrosia beetles. The black stain around the tunnels is caused by the action of the ambrosia fungus.

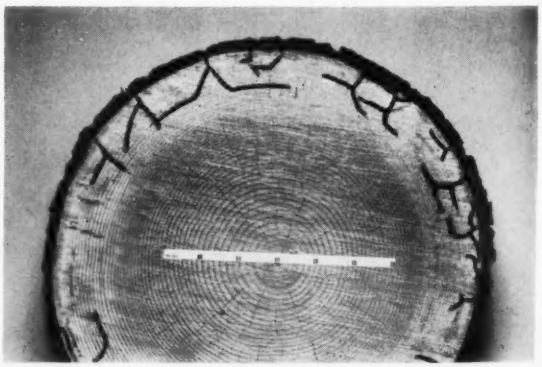

FIG. 2.—Cross section of the log in Figure 1, showing penetration and gallery pattern of Trypodendron.

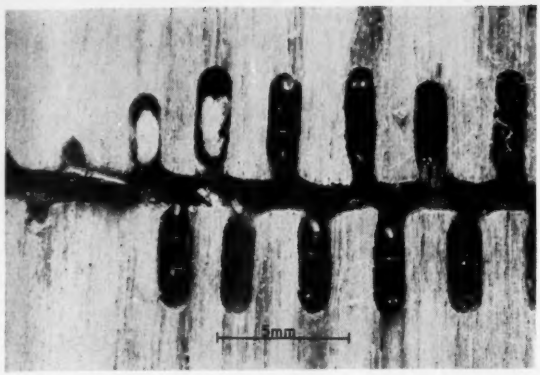

FIG. 3.—Sectioned ambrosia beetle gallery, showing the pattern typical of Gnathotrichus: a main tunnel with the evenly spaced larval cells containing insects in various stages. Trypodendron and Platypus construct similar larval cells.

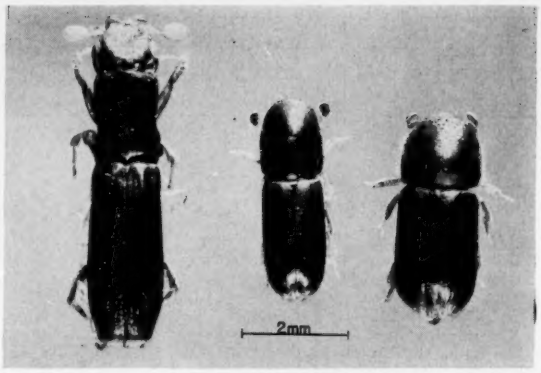

FIG. 4.—Common ambrosia beetles of the Douglas-fir region. Left to right: *Platypus wilsoni, Gnathotrichus sulcatus,* and *Trypodendron lineatum.*

trying to maintain high quality lumber. Also, recognition of severe beetle damage in the log may lead to excessive slabbing which reduces the lumber yield at the mill.

The Study

This study of ambrosia beetle activity was conducted in 1956 on clearcuttings up to three years old on Mary's Peak near Corvallis, Oregon. The study area comprised 16 clearcuttings, ranging from 2 to 20 acres and from 700 to 2,800 feet in elevation. Annual precipitation on the study area approximated 50 inches; at the higher elevations this occurred mostly as snow. Douglas-fir predominated among the timber species in this area. At higher elevations, western hemlock was found in mixtures with Douglas-fir, while at the lower elevations, grand fir was the main softwood associate. Western redcedar occurred as a minor component of the stand over the entire study area. Pacific yew was present as small scattered trees. Red alder, golden chinquapin, Oregon white oak, Pacific madrone, and bigleaf maple all occurred within the study area. The Douglas-fir stands ranged from high Site III to Site V with the average a middle Site III.

Some of the clearcuttings had been broadcast burned leaving scattered islands of unburned slash and logs. Burning was in the fall and probably did not interfere with beetle attack. Sampling was limited to unburned pieces of wood that approximated log-size with a minimum of 8-inch diameter and 8-foot length. Suitable sample logs were selected as encountered in cardinal directions from a starting point in the center of the clearcuttings. A one-square-foot area of bark was removed from the side of each sample log. Observations recorded included the number of entrance holes per square foot of log surface for each genus of ambrosia beetle, and the bark thickness and diameter of the log at the point of sampling. Bark thickness was recorded to the nearest one-quarter-inch and log diameter by two-inch classes. The genera of ambrosia beetles causing the damage were distinguished by the cross-sectional size of the entry tunnel and by the shape of the boring particles (*3*).

Frequency and Intensity of Attack

The percentage of logs infested and the intensity of attack were determined on 320 sample logs that had been exposed to ambrosia beetle attack for at least part of one summer. The percent of logs with at least one ambrosia beetle per square foot was: Douglas-fir, 93; western hemlock, 91; grand fir, 89; and western redcedar, 38—averaging 89 percent for all logs. The percent of logs attacked by different ambrosia beetles is shown in Table 1.

The intensity of attack on all logs by species of beetle in terms of 95 percent confidence limits were Trypodendron, 5.2 to 6.8 attacks per square foot; Gnathotrichus, 2.7 to 3.6; and Platypus, 0.24 to 0.74. The maximum number of attacks per square foot on the study logs was 36 for Trypodendron, 25 for Gnathotrichus, and 21 for Platypus. The highest intensity of attack occurred in a Douglas-fir log where Trypoden-

TABLE 1.—AMBROSIA BEETLE ATTACKS ON 320 LOGS OF CONIFERS IN SETTINGS NEAR CORVALLIS, OREGON

Species of conifer	No. of logs sampled	Ambrosia beetle genus	Logs attacked in terms of total	Attacks per sq. ft. of bark surface
			Percent	*Number*
Douglas-fir	232	Trypodendron	72	7.2
		Gnathotrichus	74	3.3
		Platypus	.5	.005
Western hemlock	35	Trypodendron	57	3.3
		Gnathotrichus	66	2.9
		Platypus	17	.4
Grand fir	40	Trypodendron	25	1.2
		Gnathotrichus	80	2.5
		Platypus	57	3.2
Western redcedar	13	Trypodendron	38	1.1
		Gnathotrichus	15	.2

TABLE 2.—AMBROSIA BEETLE ATTACKS ON 232 DOUGLAS-FIR LOGS NEAR CORVALLIS, OREGON

Logs grouped by—	Attacks per square foot of log surface by— Trypodendron	Gnathotrichus
	Number	*Number*
Diameter of log—		
Less than 21 in.	7.6	2.1
21 to 40 in.	7.7	3.6
Greater than 40 in.	4.3	4.3
Thickness of bark—		
Less than 0.5 in.	2.1	2.7
0.5 to 1.75 in.	7.4	2.8
Greater than 1.75 in.	3.2	6.1
Season of felling—		
Fall (Sept., Oct., Nov.)	8.9	3.4
Winter (Dec., Jan., Feb.)	11.0	4.0
Spring (Mar., Apr., May)	3.3	4.6
Summer (June, July, Aug.)	7.1	4.9
Period of exposure—		
Less than one year	7.3	1.3
One year	9.2	3.5
Two years	5.8	5.6
Three years	3.8	4.1

dron and Gnathotrichus together attacked at 45 per square foot of log surface. The mean number of attacks per square foot for all ambrosia beetles is 10.5 in Douglas-fir, 6.6 in western hemlock, 6.9 in grand fir, and 1.3 in western redcedar. Prebble and Graham (*6*) report much higher intensities of attack in British Columbia where Trypodendron alone often attacks at more than 200 per square foot of log surface.

Observations were made on the relative depths that the various ambrosia beetle galleries penetrated into the logs. Trypodendron, which attacks in the greatest numbers, seems to penetrate the wood the least. Likewise, Gnathotrichus usually confines its activity to the sapwood, but has longer side galleries, and occasionally penetrates to a greater depth. The penetration of Platypus is invariably to a greater depth than either of the other genera—sometimes to the center of grand fir logs. In general, ambrosia beetles bore to greater depths in grand fir and western hemlock than in Douglas-fir—which has a distinct and usually thin band of sapwood.

Host Preference

Analyses were run to determine the variation in intensity of attack by species of log. In the case of Trypodendron the number of attacks per square foot of bark surface varied significantly by tree species. Douglas-fir was attacked at a rate of 7.2 per square foot. As shown in Table 1, this is twice as many attacks as found in western hemlock, the species of second preference. Gnathotrichus attacked all species except western redcedar with the same intensity. Platypus averaged 3.2 attacks per square foot in grand fir and less than one attack per square foot in western hemlock. This species attacked only one Douglas-fir and no western redcedar sample logs.

Data for each tree species (except western redcedar) were analyzed to determine if the size of the log or thickness of the bark influenced attack intensity. Data were stratified by size class determined as follows: for Douglas-fir the mean log diameter plus and minus one standard deviation was considered "medium," or from 21 to 40 inches. Those above these limits were "large," those below were "small." Bark thickness was classified in the same manner resulting in "medium," ½ to 1¾ inches; bark less than this was "thin;" and more than this was "thick." These size classes for Douglas-fir showed significant variation in intensity of attack (Table 2). Similar classes for western hemlock and grand fir failed to show any significant effect of bark thickness or log diameter on intensity of attack (Table 3).

As indicated by Table 2 for Douglas-fir, Trypodendron attacks were concentrated on the smaller diameter logs with medium bark thickness, while Gnathotrichus attacks concentrated in the larger diameter and thick-barked logs. Platypus showed a tendency to attack the larger, thick-barked grand fir and western hemlock logs (Table 3). The reason for the different preferences is not known, but may be explained partly by the habits of the beetle and the moisture requirements of ambrosia fungi.

Seasonal Variation

The number of ambrosia beetle attacks in Douglas-fir logs showed significant variation from year to year. All Douglas-fir logs were grouped according to the number of years that they had been exposed to ambrosia beetle attacks. The number of attacks per square foot is shown in Table 2 for logs on the ground less than one year, and those down for one, two, and three years' exposure. The significant upward trend in Gnathotrichus attacks with period of exposure may be due to attacks on the same logs for two or more seasons following felling. The decreasing trend of number of Trypodendron attacks with period of exposure could not be explained in this manner but might be due to natural population fluctuation. None of the sample logs felled longer than one year contained fresh Trypodendron attacks. Living Gnathotrichus were found in some logs felled two and three years previously, and Platypus were found in trees known to have been dead four years.

All Douglas-fir logs that had been on the ground for at least one summer were grouped according to the season of year in which they had been felled. Only in the case of Trypodendron was the seasonal variation significant, with the number of attacks per square foot of surface ranging from a high of 11 for logs felled in the winter to a low of three in the spring. These findings agree with McMullen's report of an experiment carried on in British Columbia in which Douglas-fir and western hemlock logs felled in March and April were attacked the least by Trypodendron (*5*).

Discussion

Although this study dealt primarily with cull logs and log-sized chunks remaining after logging, the findings appear applicable to felled and bucked timber left on the ground for the same length of time. Observations on the study area and elsewhere in the Douglas-Fir Region have indicated that felled and bucked timber left in the woods for extended periods, including log decks along road right-of-ways, were attacked at intensities equal to or greater than those reported here. High-quality logs may suffer considerable depreciation in value due to degrade since "pinholes" of all kinds are prohibited in "C or Btr." lumber.

Damage may be reduced by scheduling the sequence of logging or by application of chemical sprays. Efforts should be made to remove high-quality logs from the woods as soon as possible to forestall attack by various ambrosia beetles from April to October. Trees felled in the winter months seem to be more susceptible to Trypodendron attacks in the spring of the first year. In the case of Gnathotrichus and Platypus, attacks may increase with period of exposure for two or three years. Many chemical sprays have been tested for the protection of logs against attack by ambrosia beetles. The gamma isomer of benzene hexachloride (BHC) appears the most promising treatment at the present time (*1*).

Evidence from this study indicates that ambrosia beetle attacks in coniferous logs in northwestern Oregon are not as prevalent as reported in British Columbia (*6*). However, the frequency and intensity of ambrosia beetle attacks were high enough to suggest the need for studies on the importance of these wood-boring insects in sawlogs in the Pacific Northwest.

Summary

Nearly 90 percent of the coniferous logs examined on clearcuttings on Mary's Peak near Corvallis, Oregon were attacked by ambrosia beetles of the genera Trypodendron, Gnathotrichus, or Platypus. Of four coniferous species, Douglas-fir was most frequently attacked with 93 percent of the sample logs having at least one ambrosia beetle hole per square foot of log surface. Following this were western hemlock, 91; grand fir, 89; and western redcedar, 38 percent. Douglas-fir also suffered the greatest intensity of attack with an average of 10.5 holes per square foot of log surface. Western hemlock had 6.6; grand fir, 6.9; and western redcedar, 1.3 attacks per square foot.

Trypodendron attacked all four conifers, with the highest intensity on Douglas-fir—showing preference for small to medium-sized logs with medium bark thickness. Gnathotrichus attacked all species at similar intensities except western redcedar where it occurred occasionally. In the case of Douglas-fir, there was a preference for the larger thick-barked logs. Platypus attacks were concentrated most heavily in grand fir; attacks were few to none in other conifers.

In Douglas-fir logs, there was a significant variation in the number of attacks with season of felling and duration of exposure. Attacks were fewest by Trypodendron on logs felled in the spring, and by Gnathotrichus on logs exposed less than one year. Depth of penetration of galleries into logs differed: Trypodendron shallow, Gnathotrichus intermediate, and Platypus deep.

TABLE 3.—AMBROSIA BEETLE ATTACKS ON 35 WESTERN HEMLOCK LOGS AND 40 LOGS OF GRAND FIR NEAR CORVALLIS, OREGON

Logs grouped by—	Attacks per square foot of log surface by— Trypodendron	Gnathotrichus	Platypus
	Number		
Western hemlock logs			
Diameter of log—			
Up to 20 in.	3.1	2.0	0.0[1]
Greater than 20 in.	3.4	3.7	.4
Thickness of bark—			
Up to 0.25 in.	4.3	1.5	.0
Greater than 0.25 in.	2.4	4.1	.4
Grand fir logs			
Diameter of log—			
Up to 20 in.	1.1	2.2	2.1
Greater than 20 in.	1.0	3.2	6.4
Thickness of bark—			
Up to 0.25 in	1.2	2.2	.3
Greater than 0.25 in.	1.2	2.5	4.3

[1]Platypus attacks were not prevalent enough in western hemlock to test the significance of log diameter or bark thickness on attack intensity.

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Notes

Growth Increase in Young Redwood Stands After Thinning

In 1923 Professor Emanuel Fritz made the first of a series of volume measurements on a one acre plot of 65-year-old redwood (*Sequoia sempervirens*) on a high site I. Subsequent measurements of this plot (since called the "Wonder Plot") at ten year intervals show an almost unbelievable periodic annual growth from 1923 to the present of more than three thousand board feet per acre.[1]

Equally amazing are some more recent data which apparently substantiate the fact that stands of young redwood trees on the higher sites have remarkable capacity for growth. Possibly more interesting, and certainly of value to the owner or manager of young redwood stands, is the fact that trees already 75 to 80 years of age and as large as 48 inches in diameter display substantial volume increase after thinning. Although numerous studies of the results of thinning have been conducted with various species, little information is available for redwood. Even less is known of the effect on growth of thinnings to different densities.

As a start toward obtaining more of this type of information, three one acre sample plots were laid out and measured on the south fork of the Gualala River in February 1953. All three plots are in stands similar with regard to site, age, and density. No cutting has been done in the first, while in the second and third about one-fifth and one-half, respectively, of the trees 11 inches d.b.h. an dover had been removed by a logging operation in the fall of 1951. In May 1957, measurements were again taken and compared with the 1953 measurements, as given in tabular form below. Tree size in the stands after cutting ranged from 11 to 48 inches, averaging 22 inches d.b.h. Mortality from windthrow during the four years between measurements was limited to five trees (two on plot 1, two on plot 2, and one on plot 3) totaling 1,845 board feet.

The table is self-explanatory, but an important indication to be noted is that, although the percent increase in volume of the lightly cut plot was slightly greater than that of the uncut plot, the percent increase in volume on the heavily cut plot was almost twice as great as that of the uncut plot. Future measurements are planned, not only to observe the rate of growth on these plots, but to obtain other information rapidly becoming necessary for the most economical management of young redwood stands, and to provide basic data for something beside "horseback" guesses in answer to everyday questions, such as (1) Which trees should be pruned and kept for crop trees? (2) Which ones should be cut *now*? (3) Why cut *any* of the trees now?

SILAS B. CARR
Gualala Redwoods,
Gualala, Calif.

[1]Fritz, Emanuel. Twenty years' growth on a redwood sample plot. Jour. Forestry 43:30-36. 1945.

TABLE 1.—REDWOOD STAND—AGE 77 YEARS ON SITE I[1] ONE ACRE SAMPLE PLOTS

	Plot 1 Control	Plot 2 Light cut	Plot 3 Heavy cut
Number of trees before cutting[2]	210	227	181
Volume before cutting[3]	156,055	156,505	148,350
Percent volume cut	—	21.3%	56.6%
Volume cut	—	33,320	84,050
Stumpage return	—	$166.60	$420.25
Number of trees 1953	210	203	120
Volume 1953	156,055	123,185	64,300
Number of trees 1957	208	201	119
Volume 1957	171,500	136,200	76,200
Volume increase in four-year period	15,445	13,015	11,900
Percent increase in four-year period	9.9%	10.5%	18.5%
Average annual growth for four-year period	3,861	3,254	2,975

[1]The dominants and codominants in these stands are 150-170 feet total height.
[2]All trees 11 inches d.b.h. and over.
[3]Volume from all trees 11 inches d.b.h. and over, Spaulding log rule in 16-foot logs to an 8-inch top.

Postgraduate Forestry Teaching and Research at Wisconsin

In a broad program for postgraduate teaching and research, men at the University of Wisconsin are applying to forestry many of the new principles and techniques developed in other phases of agriculture. Over 15 staff members work in forestry, a number of whom are recognized leaders in their fields. These subjecs in the College of Agriculture include forest soils, forest pathology, forest products pathology, forest entomology, tree breeding, silviculture, forest economics, and wildlife management. Contributing subjects available include bacteriology, biochemistry, ecology, mycology, plant physiology, meteorology, chemistry, physics, engineering, and so on.

The emphasis is placed on work at the graduate level rather than at the undergraduate level where it would compete with a half dozen good neighboring forestry schools. For undergraduates, Wisconsin gives a two-year preforestry course. Then the student spends the last two years required for the bachelor's degree in a neighboring forestry school.

For graduate students, about 25 half-time research assistantships

are available in the various forestry subjects. The students' courses and research lead to the M.S. and Ph.D. degrees. In 1958-1959, these assistantships pay $1,980 over a 12-month period and in addition provide exemption from the $350 nonresident tuition fee. However, all students pay incidental fees of $100 each semester to cover laboratory, library, and similar costs.

Research in forestry at Wisconsin involves close cooperation with the Wisconsin Conservation Department (which finances most of the research) as well as with the U. S. Forest Service (e.g., the Lake States Forest Experiment Station, Regional Office of Region 9, and the Forest Products Laboratory), various wood-using industries, and other agencies both public and private.

An evaluation of the progress, for example, in two subjects, appears in a survey made for the Society of American Foresters, *Forestry and Related Research* by F. H. Kaufert and W. H. Cummings (1955, p. 152): "Particular mention should be made of the Agricultural Experiment Station of the University of Wisconsin, where strong groups in both insect and disease research have been developed in the entomology and pathology departments, financed mostly by the Wisconsin Conservation Department from income derived from a special mill tax for forestry purposes. The Wisconsin project could well serve as a pattern for other states."

A broader evaluation appears in the *Forestry Chronicle* (Canada) 33: 381-383, 1957, from which we quote the following: "By concentrating on graduate teaching only, the faculty avoids being overloaded with courses and yet for a nominal sum can attract research assistants of a calibre that no government or industrial agency can afford. The presence on the campus of the U. S. Forest Products Laboratory and of strong departments in the natural sciences such as physics, biochemistry, and botany, make a wealth of specialized advice available to the individual research man. This, combined with independence in the choice of problems and lack of red tape, allows the research man to conduct a program of a flexibility and standard that his government counterpart finds difficult to match . . . Their [staff members] efforts are seconded by 20 to 30 graduate students working as research assistants. Few universities with forestry schools can boast such a program . . . The result of this co-operation between the University, the Wisconsin Conservation Department, and industry is a forestry research organization which, for its size, is probably the most productive on the continent."

A. J. RIKER
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Early Effects of Local Geographic Seed Source on Planted Loblolly Pine

Large-scale tests of the effects of geographic seed source on growth and development of the southern pines have recently been initiated.[1] In most of these tests the sources chosen were from widely scattered locations, some of which differ considerably from others in climate and soil. The object of the present study was to compare performance of loblolly pine (*Pinus taeda* L.) stock grown from seed collected in a relatively restricted region, i.e., from within or just outside Louisiana.

In the fall of 1952 loblolly pine seed was collected from five locations in Louisiana, and a lot from Arkansas was obtained from the Crossett Branch of the Southern Forest Experiment Station. The seedlings were raised in Baton Rouge and outplanted in the winter of 1954 in two locations, one in the western part of the state and one in the east. A randomized block design was used with four replications of each seed source at each planting site. The western plantation failed the first summer due to drouth. The remaining, smaller plantation near Franklinton in Washington Parish, Louisiana, provides the information reported here.

Table 1 summarizes the results at the end of the fourth growing season. Differences among the sources are small in all the observed factors and in no case are they statistically significant.

About one-fourth of the seedlings were lost the first summer, but since that time mortality has been negligible.

Incidence of tipmoth (*Rhyacionia frustrana* Comst.) has risen sharply, from 10 percent the first year to 96 percent at the end of the fourth. Despite this handicap height growth averaged better than two and one half feet this past season. Cankers induced by southern fusiform rust (*Cronartium fusiforme* Hedgcock and Hunt) became noticeable the third year and their incidence doubled the fourth year. Since many of them

[1] Wakeley, Philip C. Progress in the study of pine races. South. Lumberman 187 (2345): 137-140. 1953.

TABLE 1.—FOURTH-YEAR SURVIVAL, HEIGHT, AND INCIDENCE OF TIPMOTH AND FUSIFORM RUST FOR PLANTED LOBLOLLY PINE OF VARIOUS GEOGRAPHIC SEED SOURCES

Seed source	Distance from planting site	Survival	Average height	Tipmoth damaged	Fusiform cankered
	Miles	*Percent*	*Feet*	—*Percent*—	
Washington Parish, Louisiana	20	78	7.3	96	30
Livingston Parish, Louisiana	40	70	7.8	96	17
Rapides Parish, Louisiana	150	69	7.4	93	21
Ashley County, Arkansas	180	81	6.8	98	19
Average		74	7.3	96	22

are on the main stems, it is probable there will be some losses to the disease in the future. There is a slight indication that the local Washington Parish source is more susceptible to the rust than are the others, but further examinations will be needed to determine the significance of this trend.

In summary, at the end of four years no effects can be noted in this test of using loblolly pine seed from sources 20 to 180 miles from the planting site. Further tests are, of course, needed and are now in process of establishment.

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Comments on "The Elusive Formula of Best Fit: A Comprehensive New Machine Program"

An important contribution to biological research has been made by the above named publication by L. R. Grosenbaugh. (Occasional Paper 158, Southern Forest Expt. Sta., Forest Service, U. S. Dept. Agric., 9 pp. 1958.)

Here is real help on one of the most difficult problems facing the research forester—a fast, accurate, and inexpensive procedure for picking out the best variables to use in a multiple correlation analysis and computing the equation. It is the "open sesame" to many problems that have not been solved in the past because they were just too big. The procedure not only lets him pick out the best solution but also the next best, and all others, if he wants to omit one or more of the variables because they are difficult or expensive to measure or might not be available for use in practice.

Research foresters in general and particularly those working in the field of forest mensuration have long recognized multiple regression techniques as among the most valuable tools furnished to them by the science of statistical methods. But to a greater degree than the worker in the physical sciences, such as physics and chemistry, or even the applied sciences as typified by engineering, the forester has rarely been able to deduce on purely rational grounds the exact form or manner in which the variable quantities he is studying are related. Generally he knows, or perhaps only suspects, that a quantity under study is related in some real way to several other variable quantities that he can measure. Even in the fields of tree volume measurements and in stem form studies where the geometric figure is most evident, he has had only moderate success in determining exactly which characteristics of the tree he should measure and the form of the function or relationship, and even when he is fairly certain which variables he should measure he frequently can only guess at the best manner of expressing certain of them.

He has resorted with considerable success, however, to approximation equations where the variables, or simple functions of them, appear in a linear form and he fits a multiple regression equation by the method of least squares. This provides an estimation equation which is objective to the extent that he has been objective in selecting the form in which the variables may enter the equation and very often suits his needs as well as would the correct function assuming he were able to find it.

Unfortunately in many cases the variables are numerous. Also, if there are several reasonable forms, such as powers of the variable, reciprocals, or trigonometric functions, the effective number of variables he might use is further multiplied. Complicating the situation even further is the possibility, often perceived in practice, that the variables may enter jointly. Thus, the number of variables, functions of these variables, or combinations of the variables in product form becomes large; the clerical task of testing to determine which of the variables, their functions, or combinations contributes in a real way in explaining the variation he finds in the variable being studied becomes insurmountable. Methods have been developed for starting with a single variable and adding variables one at a time, selecting each time the variable that seems to contribute the most. The reverse procedure is that of fitting an equation to all variables and then eliminating, one at a time, the variables that seem to contribute the least. Both of these approaches are laborious and costly. Even more important, they may lead to less than ideal results, possibly because high intercorrelations exist among the variables tested, and also possibly because the apparent contribution of a variable may change, depending upon the other variables present in the combination with which it is tested. Many times the apparent contribution of each of two or more variables that may be added at a step may be so nearly equal that the choice of the variable to retain or add is reduced to a rule. This permits discarding a variable which, if it had been retained, might later have shown up to be more important than the one actually retained.

Foresters who have done much work in this field of analysis have often wished for a practicable method of analysis that would let them see the results they would have obtained if complete solutions had been carried out with all of the combinations of presumably important variables. As a result of Grosenbaugh's work as represented in this paper a facility that does this, at least for a limited number of variables, is now available.

Grosenbaugh has developed and made available a machine program for use with the IBM 704 electronic computer which will provide in a very short time, and at what appears a reasonable cost, all possible equations that can be obtained using nine independent variables

singly or in any combinations of two to nine. The program will completely and automatically handle up to 500 observations of the dependent variable and the associated independent variables. This means that if there are nine independent variables the machine program will produce 511 different formulae involving the combinations of one, two, three, up to nine variables. The cost of making this computation and supplying not only these equations but also the necessary statistical measures for testing the significance of adding or deleting a variable from any combination is estimated to lie between $50 and $250 depending upon the number of observations and variables and whether the analyst submits simply data sheets or submits the data in punched card form. As stated in this paper, the Southern Forest Experiment Station has borne a cost of several thousand dollars in developing this machine program in cooperation with the Service Bureau Corporation (a subsidiary of the IBM Corporation), but the program is made available without cost to prospective users so that users may have the computation made for merely the normal cost of operation indicated above.

In my opinion, the information packed into the eight and one-third pages of this Occasional Paper represents one of the most outstanding contributions to biological research in the entire history of forestry. Being limited to nine independent variables, and 500 observations, this procedure does not leave the research man completely without problems. He still must suspect that curvilinear or joint functions of his basic variables are most worthy of constituting the nine independent variables that the program can handle. Failure to express variables in their most suitable form or combination might result in discarding one or more which in different form or combination would have accounted for a much greater portion of the total variation of the dependent variable. With such a facility at hand, however, the researcher can make graphic tests that will indicate the presence of problems such as these; and the cost of another run testing the changed form of functions is low enough to make it practical where the question seems important. The author also asserts that the limitation of 500 observations may be overcome: a supplementary program for handling a larger number is being developed and should be ready shortly, though it will involve somewhat higher cost.

Reading this Occasional Paper is strongly recommended. Quite likely when this procedure is widely known to be available, it will find frequent use with data which already have proved intractable with desk calculators. Moreover, it will give researchers much more freedom in future studies to observe additional variables which would have been ignored because of the feeling that even if the data were made available the costs and difficulties of analysis would have prohibited their use.

It seems unfortunate, in view of the importance of this contribution, that it was not published in a medium that receives wider distribution than do the station occasional papers.

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The Balsam Woolly Aphid in the Southeast

The balsam woolly aphid, *Chermes* (Adelges) *piceae* (Ratz.), was introduced into this country prior to 1908 when it was found damaging balsam fir in Maine. Since that time this insect has spread throughout the northeastern United States, eastern Canada, the Pacific Northwest, and finally to the Southeast. This aphid is a threat to all true firs wherever they occur.

In the Northeast and Canada the aphid is found on balsam fir, in the Northwest on grand, silver, and subalpine fir, and in the Southeast on Fraser fir growing on the higher mountains of Virginia, Tennessee, and North Carolina.

Although fir stands are neither continuous nor extensive along the Appalachian chain, they do occur above 5,000 feet and are important from the aesthetic, recreational, and watershed standpoint. Many of the views along the Blue Ridge Parkway, in the National Forests, and in the Great Smoky Mountains National Park would be seriously impaired if the fir were killed.

During an inspection of Fraser fir on Mt. Mitchell in October 1957, a group of 12 trees was found to be heavily infested with aphids. Bark samples were collected, submitted to Washington, and the insects were determined to be the balsam woolly aphid.[1] The discovery of this destructive aphid this far south indicates that it is a threat to all true firs throughout the eastern part of the United States. Loss of the Fraser fir from the popular Mt. Mitchell State Park, which includes the highest point in the eastern United States would be particularly unfortunate.

A closely related species, *Chermes nusslini* Borner, was found damaging Fraser fir near Luray, Virginia, in 1956 and killing trees in a manner characteristic of *C. piceae*.[2]

Bark of infested trees is covered with a white, woolly, waxy material under which the insects are located. These small insects—less than one-sixteenth inch long—cause two principal types of damage. Insect attack on the trunk produces

[1]Determined by L. M. Russell, Insect Identification and Parasite Introduction Section, Agric. Res. Serv., U. S. Dept. Agric., Beltsville, Md.

[2]McCambridge, W. F., and R. J. Kowal. Forest insect conditions in the southeast during 1956. Forest Service, Southeast. Forest Expt. Sta. Paper 76, 5 pp. 1957.

thick-walled vessels, reddish discoloration of the wood, and brittleness. Attack on limbs, buds, and twigs causes swelling similar to a "gout" condition and they become deformed. Attacks lasting for several years cause dying of limbs or death of the entire tree.

Most of the remaining Fraser fir has little commercial value from the utilization standpoint because of its size, limited accessibility, and relatively small acreage. Therefore, it does not appear practical to advocate silvicultural or management control methods.

Chemical control may be justified because of the recreational, aesthetic, and watershed value involved and the limited range occupied by Fraser fir. Miscible oil, contact, and residual-type sprays have effectively controlled this pest and may be used where fir is desirable as a component of the forest or as an ornamental tree.

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Diluted 2,4,5-T More Lethal Than Undiluted in East Texas

For inhibiting sprouts from freshly cut post oak and sweetgum in east Texas, 2,4,5-T was more effective when diluted with diesel oil than when undiluted, provided that the amount of acid equivalent in diluted and undiluted doses was equal. A double dose of undiluted chemical was nearly as good as the dilution, and might be practical where transportation of diluent is very expensive.

In April 1955, six neighboring areas were located, three of which were devoted to post oak (*Quercus stellata*) comparisons and three to sweetgum (*Liquidambar styraciflua*) comparisons. On each area, 80 trees less than 3½ inches in d.b.h. had stems severed close to the ground. Then 20 trees on each area were randomly assigned to each of four treatments applied immediately after cutting. A total of 480 small trees were used; the treatments were as follows:

A. Dow Esteron 245 diluted with diesel oil until the concentration was 19 pounds of acid equivalent per 100 gallons of final mixture. Dosage per stump equalled 0.00110 pound of acid equivalent.

B. Undiluted Dow Esteron 245 applied in a concentration of 400 pounds of acid equivalent per 100 gallons of liquid. Dosage per stump was 0.00117 pound of acid equivalent—about the same quantity of acid as in treatment A.

C. Same concentration as in B, but a double dose—equal to 0.00234 pound acid equivalent per stump.

D. No chemical.

In December 1956, 98 percent of the stumps dosed with the diluted chemical (A) were free of sprouts, as compared with 93 percent of the stumps that received the double dose of undiluted chemical (C) and 80 percent for those that got the single dose of undiluted chemical (B). Of the stumps receiving no chemical, only 27 percent were sprout-free. Analysis of variance of percentages (transformed to angles of equal information) indicated that neither species difference nor species-treatment interaction was significant, but that treatment differences were highly significant. When treatment sum of squares was partitioned into the three logical orthogonal comparisons (chemical vs. no chemical, diluted vs. undiluted, and single dosage vs. double dosage), the first two comparisons were highly significant and the last was significant. "Significant" implies the 5 percent level, in a statistical sense, and "highly significant" implies the 1 percent level.

Results like these can be expected only when the chemical is applied during the growing season. Similar applications during December were ineffective, though the sprouts were somewhat delayed in appearing.

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Points of View

Comments on Stumpage Costs

"The Trend of Lumber Prices" by Joseph Zaremba in the March 1958 issue of the JOURNAL is a challenging paper. Rising wages without an accompanying rise in lumber productivity is a grim reality we must face up to, but no worse a reality than rising stumpage prices. Although Zaremba states, "To be sure, if stumpage prices continue to increase at a faster rate than lumber prices, stumpage prices will become a more and more important factor in the lumber price trend," he tends to minimize the effect of stumpage cost we must know how it He states "As recently as 1940, stumpage averaged only about 5 percent of all lumber costs; before 1900 it was insignificant."

If 5 percent is to be accepted as a true average nationally for 1940 stumage cost we must know how it was determined. National averages for stumpage costs in any one year can be very misleading. Average dollar figures for stumpage costs in any one year are influenced by the amount of short term as well as long term stumpage converted. Recessions in the lumber industry are always accompanied by declining production from the smaller mills that are dependent on short term stumpage and to a lesser degree by the large mills who own substantial acreage in fee simple or lease timber rights for 5 to 15 years. National forest shortleaf pine stumpage brought $7.00 per M bd. ft. in Arkansas during 1937 when lumber realization averaged but $21.00 per M, one-third then, of lumber costs. Two decades later, similar stumpage brought $35.00 to $50.00 per M, close to 50 percent of lumber cost. Comparable stumpage brought $10.00 in North Georgia in 1944, about 20 percent of lumber cost and $36.00 in 1957, close to 50 percent of lumber cost. Yet, 5 percent could be a valid average for the year 1940 as lumber realization had not yet risen enough to encourage the operation of sufficient short term stumpage to reflect a higher figure. If we assume $30.00 as lumber cost in 1940 and 90 percent of production from long term stumpage charged off at $1.00 per M, we have room for 10 percent short term production at a cost of $6.00 per M. This assumption can be challenged as an oversimplification, but it is not inconsistent with the oversimplification we assume when we accept any figure as a national average cost of stumpage. What was reported as stumpage cost by long term stumpage operators in 1940? March 1911 evaluations? Acquisition cost? Capitalized cost? Probably what the Bureau of Internal Revenue permitted at the time.

Nevertheless, the challange to forestry is clear. The silviculturist must learn to grow more and higher quality per acre and our utilization men are going to have to develop lower cost harvesting methods if per capita consumption of lumber is to be maintained or to be increased.

LEE S. SETTEL
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In Reply

According to Steer, the average stumpage price in the United States during 1940 was $2.61 per M bd. ft.,[1] and the average lumber price during the same year, f.o.b. mill, was $23.32.[2]

The latter figure, however, does not include the cost of re-manufactured lumber, such as millwork and flooring, or the cost of lumber distribution. In 1940, southern yellow pine roofers sold for about $30 per M in New York, f.o.b. cars; 2×4 yellow pine dimension, $44.50; and the different grades of oak flooring varied in price from $45 to $93.[3]

The average wholesale price of lumber in 1940 was therefore considerably higher than $23.32. If the average price in 1940 was $35 per M, the cost of stumpage as a percent of wholesale lumber prices was 7½ percent.

But, as Mr. Settel points out, a large portion of the 1940 lumber production represented "long term stumpage," that is, stumpage purchased prior to 1940 at prices different from those prevailing in 1940. The use of 1940 stumpage prices to compute the above percentage must indeed be regarded as an oversimplification of the problem.

JOSEPH ZAREMBA

[1]Steer, H. Stumpage and log prices for the calendar year 1941. U.S. Dept. Agric. Stat. Bull. no. 78. Gov't Printing Office, Washington, D. C. p. 16. 1952.

[2]Steer, H. Lumber production in the United States 1799-1946. U. S. Dept. Agric. Misc. Pub. no. 669. Gov't Printing Office, Washington, D. C. p. 24. 1948.

[3]The New York lumber trade journal. 1940. Volume CVIII.

Lumber Prices and Labor Productivity

In his recent discussion of lumber prices Joseph Zaremba performs a useful service in calling attention to labor costs and labor productivity in the lumber industry.[1] However, he does not do his argument a service when he concludes his non-algebraic presentation with the statement that "rising per capita real income in the American economy may thus be thought of as the cause of the upward trend of lumber prices." Actually, a better summary of the

[1]Zaremba, Joseph. The trend of lumber prices. Jour. Forestry 56:179-181. 1958.

main line of argument appears to be the quite different statement that "the trend in the real price of lumber depends, fundamentally, on the relation between the trend rate of change in productivity in the economy and that in the lumber industry."

However, far more unfortunate than this confusion in the presentation is Zaremba's reliance on the labor theory of value in explaining lumber prices. His explanation would be valid—though certainly not fundamental—if labor were the sole input both in lumber production and in the general economy. Since this is not the case, the conclusions tend to be misleading.

Despite its wide usage in economic discussions, the "productivity of labor" is a statistical rather than an economic concept. It is determined simply by dividing total output by the total number of labor inputs. However, production of the output requires inputs of capital (including raw material) as well as inputs of labor. Indeed, probably the most characteristic route for increasing the productivity of labor in our economy is through combining more capital with labor. This, in effect, involves replacing a labor cost with a capital cost. When the marginal cost of the capital is less than the marginal cost of the labor, methods of production are changed, the industry becomes increasingly capital intensive, and the "productivity of labor" rises. If, on the other hand, the cost of the additional capital is greater than the saving in labor cost, the change is not made, and, other things equal, the "productivity of labor" remains unchanged.

There is a lack of readily available data as to trends in "labor productivity" in the lumber industry. Thus it is not possible to determine quickly whether or not the experience of the last decade is consistent with Zaremba's thesis. Certainly his citation of a study published in 1946 and based on wartime conditions in the Southern lumber industry cannot be accepted as the basis for any conclusions concerning post-war trends. In any case, discussion of "labor productivity" in lumber involves some peculiar difficulties. The industry is engaged in the mechanical processing of a raw material, but over the years the nature of the raw material has changed. Until very recently the forest resource has been a declining resource. Manufacturing lumber under these conditions has meant going farther back and higher up in the West and shifting to scattered stands lightly stocked with small trees in the East and South. Major adjustments in technology have occurred in response to this, although for a variety of reasons the adjustments have been less capital intensive than is generally true of the American economy. There can be little doubt, however, that the modern large-scale lumber operation would require far less man-hours per thousand board feet than the similar operation of fifty years ago *if both operations were based on the same forest conditions.*

Under the generally accepted theory of price, both price and quantity of consumption are considered to be determined simultaneously by the intersection of supply and demand. It is doubtful that much meaning can be attached to discussions of price or cost which do not also consider quantity and which do not consider demand as well as supply. As has been discussed more fully elsewhere,[2] the particular pattern of volume and cost which has characterized lumber over recent decades is best explained by the combination of increases in demand with decline in a supply schedule which is markedly inelastic at the upper ranges of production experience. In these terms, Zaremba's concern is with the reasons for the decline and the inelasticity of the supply schedule. The "labor productivity" approach is simply not adequate for this task. It does not consider the fact that labor is only one of the inputs involved in the production of lumber, and fails entirely to recognize the significant changes in production context involved in any forest-based industry over the last fifty years.

It is true enough that labor is a major cost element in the production of lumber and that technological developments to reduce labor requirements per thousand board feet of output may well be crucial to profit margins in the industry. It does not follow from this, however, that such reduction in labor costs would have any particular effect on price. Supply involves both cost and volume. Careful analysis of past experience will show that within the current range of production levels the most probable effect of a reduction in costs at a particular level of output in the industry would be a very minor increase in total volume accompanied by reestablishment of practically the same price level as previously.

The reasons for this will be found in the forests which are the source of the raw material. In the past foresters have been all too prone to believe that a declining timber resource results in a "timber shortage" with direct and major impact on the ultimate consumers of the services of lumber. Instead, in a flexible economy with technological alternatives the major impact is on the lumber industry, not on society. The structure of the industry, its cost patterns, and its supply responses are direct expressions of the changes in its resource base under the conditions of wide geographic dispersion of that resource and accompanying lack of concentration of control combined with technological means for operation with low capital investment. It is in these circumstances, not in rising per capita income, that the fundamental causes of the upward trend in lumber costs must be sought. To the extent that the relative trends in "labor productivity" between lumber and the general economy do correspond to the relationship postulated by Zaremba, they must be considered as simply an alternative and less meaningful expression of the same underlying

[2] Zivnuska, John A. Supply, demand, and the lumber market. Jour. Forestry 53(8):547-553. 1955.

forces which explain lumber's costs.

JOHN A. ZIVNUSKA
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In Reply

If I understand him, Mr. Zivnuska harbors two main objections to my analysis, one having to do with the labor theory of value, the other concerning the effect of cost changes upon lumber prices.

As for the labor theory of value, it was a live issue when it was being taught by Adam Smith in the Eighteenth Century and by Ricardo and others a little later, but today few free-world economists accept it or even find much in it to argue about. Nowhere in my analysis do I state or imply that lumber value is determined solely by labor.

On the other hand, I do use the idea of gross labor productivity, or output per worker, which Mr. Zivnuska labels as a statistical rather than an economic concept. I am interested in the concept not so much for its pedigree as for its usefulness. Comparative productivity trends are generally recognized as valid indicators of comparative long-run price trends. Let Mr. Zivnuska read, for example, M. Fourastie's paper on economic progress, presented in 1955 to the International Economic Association round table, where it is stated that: "Within one nation, the prices of two products are in inverse ratio to the productivities.[3]

As for lumber cost and price changes, Mr. Zivnuska evidently believes that holding costs down would not "have any particular effect on price." This view is not widely shared within the lumber industry itself. Indeed, one of the trade journals editorialized not long ago that "it is inconceivable" that any manufacturer of lumber "is not well aware of the fact" that an increase in his cost of production will "decrease his profits or else make it necessary for him to get a higher price for his product."[4] Whether the effect in the long run will be upon profit or price is scarcely debatable.

The remainder of Mr. Zivnuska's discussion lends helpful detail to my thesis. Improvements in logging and milling technology, he explains, have barely counteracted adverse trends in timber stocking, quality, and location, leaving productivity in the industry about constant.

Since productivity in the economy tends to increase at a progressively faster rate, the upward trend of real lumber prices will likewise steepen unless the industry raises its productivity. The benefits to be derived from increasing productivity are clearly indicated in the following quotation: "The object of the drive for increased productivity is not merely to improve the technical and economic position of firms, widen the difference between selling price and costs—in a word to increase profits. Its main goal and result is to bring down selling prices and speed up social progress and more particularly raise living standards and the purchasing power of wages and salaries."[5]

JOSEPH ZAREMBA
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[3]Fourastie, J. The statistical measurement of various material aspects of economic progress. Papers and Proceedings of a Round Table held by the International Economic Association. Edited by L. H. Dupriez. p. 81. 1955.

[4]Southern Lumberman, July 1, 1955; p. 20.

[5]Fourastie, J. Productivity prices and wages. Project 235. The European Productivity Agency of the Organization for European Economic Co-operation. Paris; p. 15. 1957.

Some Questions About the 1957 Forestry School Statistics

After looking over the recent article, "Statistics from Schools of Forestry for 1957,"[1] I am of the opinion that this title may be misleading. The reader might assume that all of the various speciailized fields are given at schools of forestry and are probably closely related to the field of forestry. I know of one institution where this is not the case and I wonder about curricula in other schools of the 37 included in the statistics. Many readers might assume that the total of 7,395 is the number of undergraduate "foresters" for the fall term, 1957-1958. I do not think that it can be interpreted in this way.

The specialized curricula grouped in the category "Others" are probably the most questionable. It is possible that courses given in packaging, plastics, conservation education, rural land use planning, landscape gardening, soil conservation, light construction, and lumber merchandising may have little connection with a forestry school or with the field of forestry, even if the scope of the term forestry is stretched to its limits. I know of teachers and students in these specialized fields who would be amazed to know that they had been included in the statistics of forestry schools.

It is also possible that other specialties such as wildlife management, range management, and some curricula in forest recreation (or park management) may have little or no connection with a forestry school or the field of forestry. I know of curricula in wildlife management and park management included in the statistics that have only one or two forestry courses, or sometimes none at all.

I wondered why some undergraduate specialized fields were left

[1]Marckworth, G. D., Statistics from schools of forestry for 1957: degrees granted and enrollments. Jour. For. 56: 129-135. 1958.

out. It seems to me that plant ecology, and some phases of plant pathology, entomology, and soil science could be included. At some institutions it might be easier to justify including these in the statistics than some of the curricula in the "Other" category.

Perhaps the title of the statistical review could be changed to indicate the broad coverage, if it seems desirable to include a great variety of curricula and administrative situations. I believe a better approach would be to include in one statistical summary only enrollments of specialized fields containing at least the five basic professional courses required in the approved curricula for professional forestry education by the Society of American Foresters. If this or similar criteria were used, all schools would be reporting on an equal basis and the total enrollment would indicate the number of "foresters" trained or being trained. A summary of enrollments of the other curricula could be presented separately.

L. W. GYSEL
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Comments on the Discussion of Policy Matters

I would like to have the privilege of commenting on the article by W. D. Hagenstein in the April 1958 issue of the JOURNAL OF FORESTRY, page 300, titled "Professional Responsibility."

Mr. Hagenstein's suggestion that controversial policy matters be given plenty of opportunity for discussion in Society meetings is very excellent indeed. His statement that persons not qualified in forestry matters may otherwise dictate forestry policies is well taken.

Such discussions have taken place for many years in meetings of the Puget Sound Section and of its Chapters. If these discussions had been along the line of "professional expression" and the voicing of "our own beliefs," as mentioned by Hagenstein, the discussions would have been entirely proper and would undoubtedly have resulted in public recognition and approval of actions taken by the Society. Unfortunately this has seldom been the case in such discussions. Almost invariably the discussions have been fostered by individuals or small groups within the Society who are not voicing their own beliefs and not giving vent to professional expression, but rather to partisan political propaganda and points of view which are dictated by employers.

When forceful individuals or previously organized small groups present certain policies before Chapter meetings they are apt to sway the thinking of members who have not given the subject under discussion much previous thought, and who take the word of its proponents for granted. If individual members oppose these "steamroller" movements, which always urge unanimous vote by a Chapter, they are scorned, criticised, and often openly ridiculed.

Such tactics were employed several years ago when the writer dared to express a minority opinion on the establishment of the Olympic National Park in a meeting of the Puget Sound Section.

If we can obtain unbiased and professional discussion of policy matters before Chapters and Sections of the Society of American Foresters, well and good. If such discussion, however, is to secure resolutions from any unit of the Society which are to be used for purposes of partisan politics or selfish interests, the Society will lose its professional status and will come into bad repute with the public and intelligent laymen.

DONALD H. CLARK
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Reviews

Water Resources

In Law and Contemporary Problems 22 (3) : 323-537. Duke University Press, Durham, N. C. Summer 1957.

This symposium concerns water resource programs and the difficulties of establishing a national water policy. The eight papers by authorities in this field present current programs and attempts at policy-making in an interesting and often engaging style. Since these problems appear enduring, this volume should make a lasting reference.

The first paper, *Federalism and Water Resources Development,* by Ernest A. Engelbert describes the dominant role the federal government has taken in water-resource development, in part through state default, and explores some courses of action that would strengthen state participation. Roscoe C. Martin's paper on *The Tennessee Valley Association: A Study of Federal Control* is a sympathetic and knowledgeable account of this agency. Foresters will be particularly interested in his discussion of the history and activities of the Authority's forestry program and his statement that the eclipse of the resource-based activities in recent years has increasingly given TVA the appearance of an electric utility corporation rather than an agency for regional development.

In the same year TVA was created, 1933, the Muskingum Watershed Conservancy District was also born. Lyle E. Craine's report on this development brings out its early distinctive difference —local control—and subsequent loss of local independence through cost-sharing with the federal government. Robert J. Morgan's paper on the small-watershed program of the U. S. Department of Agriculture makes interesting reading, detailing the historical development of the flood-control program within the department. In a thoughtful conclusion he notes:

> It may be carrying pessimism too far to say that even a President cannot act effectively until crisis is upon us, but the course of history well demonstrates the force of inertia in the affairs of men. For that vast majority of Americans who can confidently expect a twist of the spigot to produce pure water in sufficient quantities to meet the demands of civilization, this issue is too distant to compete with the grinding of meal for daily bread or with the imaginable terrors of the jungle of international politics. The climax, of course, may soon be upon us, for if present estimates are accurate, we shall be prospecting for every drop of water, even in the humid East, within a decade or two. Until then, without leadership, we cannot expect the level of public concern with the issues to rise above the kind of amused incredulousness prompted by the revelation that grizzly bears are administered by one federal department, brown bears in a second, and polar bears in yet a third.

The well-known "partnership" policy of the present administration is analyzed in Roy E. Huffman's paper, *The Role of Private Enterprise in Water Resource Development,* ". . . mainly from the standpoint of intent rather than performance. There is little, if any, experience to which one can turn in the way of functioning projects or programs demonstrating the partnership policy in action."

Six major recommendations for a national water resource program, produced during the past decade, are described in James W. Fesler's paper, *National Water Resource Administration.* He also points out attendant inconsistencies and what appear to be insuperable difficulties in securing a workable program. Irving K. Fox in his paper *National Water Resources Policy Issues* continues the evaluation of these reports in relation to objectives, federal responsibilities, costs, and policy issues of flood management, irrigation, power, and water supply. Finally, Henry C. Hart's paper entitled, *Crisis, Community, and Consent in Water Policies,* describes how crisis decisions, in response to major floods, have determined water resource policy.

The symposium opens with a statement that the best use of our water resource continues to pose a national challenge and closes with the statement that we have fresh thinking to do.

HOWARD W. LULL
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Conservation in America

By Dorothy Childs Hogner. 240 pp. Illus. J. B. Lippincott, Philadephia. 1958. $3.75.

This seems a commendable book for several reasons. First of all the author has written well about a difficult subject. Conservation is a difficult subject because it is difficult to define. Yet people always are writing about it.

Second, she writes mainly about what she knows first hand—from personal notes kept during travels ranging from deserts to Canada, from bayous to New England. Her husband decorates the cover, title page, and chapter headings with a few simple drawings; not nearly enough from so competent an artist, to my way of thinking.

Third, this book offers refreshing coverage of conservation projects and problems in the eastern United States as well as in the West. I say refreshing because many popular writers on conservation convey, perhaps unintentionally, the notion that forests, waters, fish, and wildlife are exclusive western property. They may concede the nastier erosion gulleys to the East or Midwest, while rhapsodizing the Wallowas or the Tetons as if no other beauty spots exist in our great nation. Mrs. Hogner is too perspective to confine herself to the "I've Been

Slapped in the Face by Grandeur" school of writing. Her approach while informal, is not too cozy. With a vignette arrangement within larger chapter headings, she never digresses too far from factual writing. Each vignette centers upon a fact.

The Hogners have a farm in Connecticut, and it is there they became confirmed observers of deer, trout, birds, trees, and streams. The warmest writing in the book is about animals, remindful of a book for which Mrs. Hogner and her husband are well known: *The Animal Book: American Mammals North of Mexico,* which came out in 1942 as an introduction to natural history for older children. Presumably, *Conservation in America* is designed to be an introduction to conservation for older children or for young adults.

One of the faults in the book, and it may be the publisher's fault as well as the author's, is that one is not quite clear about the audience Mrs. Hogner is trying to reach. The vignette arrangement and the nontechnical chapter headings suggest reading for pleasure rather than for reference or schoolwork. Factually, however, the book is more technical than many textbooks on conservation.

The next fault is more serious. In a book purporting to introduce young readers to the subject of conservation, we have a right to expect the author to suggest at least the names of great writers on the subject. John Muir, Aldo Leopold, or even Ernest Thompson Seton are people to whom young conservationists or naturalists should be introduced early. Yet I find no mention of them in Mrs. Hogner's book.

Acknowledgments in the Introduction show that Mrs. Hogner has checked her facts and her terminology with people who ought to know the correct answers. She has written informatively and informally about things for which young Americans should feel great concern. In all she has done a good job.

FRANCES J. FLICK
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Forest Soils: Their Properties and Relation to Silviculture

By S. A. Wilde. 537 pp. Ronald Press, New York. 1958. $8.50.

The appearance of a new textbook on forest soils is a welcome event, especially when it is written by one of the leading teachers in the field. Sergei Wilde's book is only the second American textbook on the subject, and one of the few modern and comprehensive treatises on forest soils in any language. The present text clearly shows the influence of the author's earlier monograph on "Forest Soils and Forest Growth," but is a new, more exhaustive, and original contribution.

Dr. Wilde, professor of soils at the University of Wisconsin, has long been active in research in the Lake States on the application of forest soils knowledge to silvicultural problems, and has an extensive background of training and field experience in eastern Europe and elsewhere.

Anyone who looks for a formal or standard discussion of the forest soil in accordance with "recognized" American practice and nomenclature obviously does not know the author and will be disappointed in the book. On the other hand, those who are stimulated by contact with an unusual, well-informed, and inquiring personality will find a great deal of pleasure from reading it.

The book is divided into two parts. Part I, "Soil as a Medium for Tree Growth" covers in 317 pages most of the material relating to forest soils in the conventional sense. Part II, "Soil Science and Silviculture" occupies 175 pages and comes directly to grips with the application of forest soils knowledge in practical forestry.

The ten chapters in the first part are conventional in their titles and order, dealing with the history of forest soil science, soil minerals, soil organisms, forest humus, soil formation, and the major soils groups, physical and chemical properties, and soils-plant correlations.

The text introduces a great many technical terms, many in common usage and many more either coined by the author or adopted by the author from previous investigators.

The value of such a precise terminology is unquestioned, and there is but little doubt that a good many of the less familiar terms defined will find widespread acceptance by the professional. Nevertheless, many reasonably well trained forest soil scientists will find it necessary to learn a new dialect of their language as they go.

It is impossible to provide more than an introduction to the many aspects of basic soil science that must be covered in the first part. It is not surprising, therefore, to find that discussions of single points are apt to be short and sometimes even leave the reader without a clearly formed conclusion. Statements such as "The enormous area of forest soils affected by podzolization and laterization supports rapidly growing forest stands in complete absence of earthworms" make the reader wish that facts, figures, and citations could have been added to expand and document the problem. Unfortunately such is not possible nor perhaps even desirable in a book that covers a whole discipline in a few hundred pages.

Part II is concerned with practical soil problems such as the management of nursery soils, the control of parasites and weeds, soil classification and analysis as a guide for reforestation, the improvement of unproductive forest soils, and the effect of soils upon silvicultural cuttings.

The section on nursery soils seems to be praticularly valuable and reflects the author's wide experience as a consultant on nursery soil management. The discussion of soil improvement benefits a great deal from Professor Wilde's own knowledge of such work in northern and eastern Europe.

The book seems to this reviewer to possess two outstanding qualities. First, it provides the American forest soils specialist with a good introduction to the Russian, German, and other European forest soils lit-

eratures, and with concrete examples of the work of men in these countries. The availability of a book relating American soils research and experience to those of the European countries is invaluable.

The second and more important outstanding quality of the book is its documentation of the extensive investigations of the author, giving us his mature evaluation of his own contributions and presenting many detailed examples involving the forest soils and vegetation of the Wisconsin region.

The emphasis on personal experience and investigations—although the world literature is well represented—does lead to a certain deemphasis of the problems of American forest regions other than the Lake States, and of the research produced by scientists of other schools of thought around the country. Again, however, the permissible length of the book limits its encyclopedia potentialities, and it would have been unfortunate if less space were given to the aspects of forest soils with which Dr. Wilde has been most deeply concerned.

Forest Soils: Their Properties and Relation to Silviculture is clearly an important addition to American forestry literature, and one that will be studied and referred to from now on.

STEPHEN H. SPURR
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Publications of Interest

The Directory of American Horticulture for 1958 is published by the American Horticultural Council. This 80 page directory contains the names and addresses of 418 national, regional, and state horticultural organizations in the United States together with the name and address of the president, the secretary, and each organization's publications.

Also included are the names and addresses of the 103 botanical gardens and arboretums in this country, together with 61 non-commercial garden centers. Two hundred and ninety-four universities, colleges, and junior colleges teaching horticulture or its related subjects are also listed. All the major horticultural periodicals of the country are listed together with the names of their respective editors.

This valuable publication is available from the office of the Secretary of the American Horticultural Council, c/o Arnold Arboretum, Jamaica Plain 30, Mass. Price $1.50.

* * *

More Timber Faster is a new booklet prepared by The Dow Chemical Company describing the use of herbicides and silvicides to remove overtopping hardwoods and release conifers, to kill competing undergrowth, to clear areas for reseeding and to maintain fire lanes, access roads and work or storage areas free of undesirable vegetation. The booklet is available free of charge from Agricultural Chemical Sales, The Dow Chemical Company, Midland, Mich., or from any Dow sales office.

* * *

The Osmose Wood Preserving Company announces a new color-sound film, *The Wonder Wood.* With a showing time of 21 minutes this 16mm film illustrates the story of wood—its many matchless qualities, its few weak points and how they are eliminated—and of pressure wood preservation.

Availability for showings: Contact Joseph M. Bray, Osmose Wood Preserving Company, 980 Ellicott Street, Buffalo 9, N. Y.

* * *

The 6th edition of the *Forest Farmer Manual* has been issued by the Forest Farmers Association, 66 11th St., N.E., Atlanta, Ga., bringing to tree farmers in the South a new up-to-the minute guide to the growing, harvesting, and marketing of timber. The work of 44 forestry and timber experts, it is the most comprehensive edition yet issued, its expanded coverage ranging from new techniques and practices to a roster of the region's key foresters and wood procurement men. Price $4.

* * *

A progress report of Mission 66 after its first full year of operation is being distributed by the Department of the Interior in a booklet entitled *Mission 66 in Action.* The booklet lists briefly the accomplishments made in improving facilities such as campsites, overnight accommodations, roads, and exhibits.

Current Literature

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Society Affairs

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The Council's Column

Professional Recognition

Over the past several months I have been privileged to attend meetings of nine of the 21 Sections of our Society. I have been impressed with the programs, with the effective participation of those at the meetings, and with the manner in which the Section officers and committee members have been doing their jobs. The themes of these several sessions have been quite diverse, reflecting particular interests of the individual sections; yet the meetings have touched on some common ground.

Concern has been repeatedly expressed about the doubtful recognition accorded the forestry profession by the general public and, more particularly, by those men in the industry who hire foresters. Despite our own convictions as to the growth and accomplishments of our calling in the past half-century, forestry still fails to share the general public understanding and regard enjoyed by engineering and other recognized professions. To the layman, a forester's work is too often considered as limited to such pursuits as planting trees, manning a lookout tower, or carrying on various activities associated with an idyllic enjoyment of life in the great outdoors. This massive lack of understanding reminds us all that our efforts to teach people the real meaning of professional forestry have met with quite limited success.

Part of the difficulty lies in our lack of extensive professional contact with the public. Outside of those areas in which timberland contributes importantly to the local economy, foresters and forestry are seldom in the public eye. However, a special opportunity for a better general understanding of forestry and its objectives is now presenting itself, as the multiple-use aspects of our management programs find more extensive application. This is especially the case when we deal with hunters, fishermen, campers, and the others who are turning in ever-increasing numbers to the forests to satisfy their desires for outdoor recreation. Effective public relations with these groups can do much in the years ahead to enhance our professional status in the eyes of the general public.

Another part of our difficulty in attaining greater professional recognition lies in the specialization that marks our training, the vocational aspect of much of what we do, and, in consequence, the attitude employers often hold toward a forester's work and his potentialities. More and more we hear demands for "leaders and managers" of men and enterprises rather than for "narrow specialists." Technical skills are still the main stock-in-trade of the young forester. But if he aspires to a position of leadership, he is expected to have, or to acquire, much knowledge of human behavior.

A third source of difficulty in gaining status is the fact that our forestry schools have consistently trained more students than could find immediate em-

REED W. BAILEY

ployment at the technical level. Faced with a supply of professionally trained men far exceeding their "needs," many employers developed practices in hiring foresters that now seem dubious. Today, however, first-class men with a professional training no longer snap up offers of essentially sub-professional jobs, lacking opportunities for reasonable advancement. Of course, the question of the forester's professional status and the work he is suited to are answered not so much in the technical or philosophical literature as in the market place. Supply and demand regulate professional employment in conventional fashion: Foresters were "stockpiled on the rigging" when they were relatively cheap. A change in the market place—in this case an increase in the effective demand for their services—has been doing more than all our speeches to correct inequities in the status of foresters, both as professional men and as leaders.

Candor compels one further observation, even at the risk of seeming to preach: As with other things, reputation and respect usually begin at home, with individual foresters and within the profession. We must beware of any tendency, however inadvertent, to regard this question of status as a problem to be solved solely in terms of "advertising" and public relations. For in the long run, our worth and our reputation will be largely what we ourselves make them. Our attitudes and actions, as individuals and organized groups, hold the key to the professional recognition we will be accorded in the years ahead.

GEORGE A. GARRATT

Annual Meeting

Society of American Foresters

"Multiple-Use Forestry in the Changing West" is the theme of the 58th annual meeting, scheduled for Salt Lake City, September 29-30 and October 1-2.

Co-chairmen Floyd Iverson and Reed W. Bailey report that preparations are under way for one of the most interesting meetings of foresters ever sponsored by the Society. An attendance of one thousand is expected.

The meeting will be formally opened by President George A. Garratt at 9:30 a. m., Monday, September 29. George V. Hjort, past chairman of the Intermountain Section, the host Section, will be chairman of the first general session.

There will then follow the Society Affairs session, nine subject Division meetings, the annual dinner, and an all-day field trip.

Henry J. Malsberger, vice president of the Society, will preside as toastmaster at the Society's dinner on October 1, at which President Garratt will make two noteworthy awards. The Sir William Schlich memorial medal for distinguished service to forestry will be presented to an eminent American forester. Also to be presented will be the award for achievement in biological research leading to the advancement of forestry.

The featured speaker at the dinner will be Dr. Tom Gill, executive director of the Charles Lathrop Pack Forestry Foundation and Schlich medalist in 1954.

Ladies are welcome and invited. Special programs are being planned for them. Among their activities will be tours to the world famous copper mine at Bingham, Great Salt Lake, and the Alta winter sports area in the Wasatch Mountains.

The complete program for the meeting, including all scheduled speakers and the titles of their papers, will be published in the August issue.

The Field Trip

A field trip, for men only, will be made on Thursday, October 2 to the Davis County Experimental Watershed to inspect the watershed activities of the U.S. Forest Service and to see aerial forest fire fighting tactics. Travel will be by open trucks over 40 miles of mountain road into high country unsurpassed for geologic, historic, and scenic features. No private passenger automobiles will be permitted, in the interest of safety.

A box lunch with hot and cold beverages will be served. Clothing for cool mountain weather will be desirable.

The cost of the trip will be about $2.50.

Those desiring to take this trip will be required to register for it in advance. Note the hotel reservation form on page 529.

Schedule of Events

Saturday, September 27

Council of Forestry School Executives; morning and afternoon.

Sunday, September 28

SAF Council; morning and afternoon.

Editorial Board, JOURNAL OF FORESTRY; evening.

Association of Consulting Foresters, open meeting; evening.

Monday, September 29

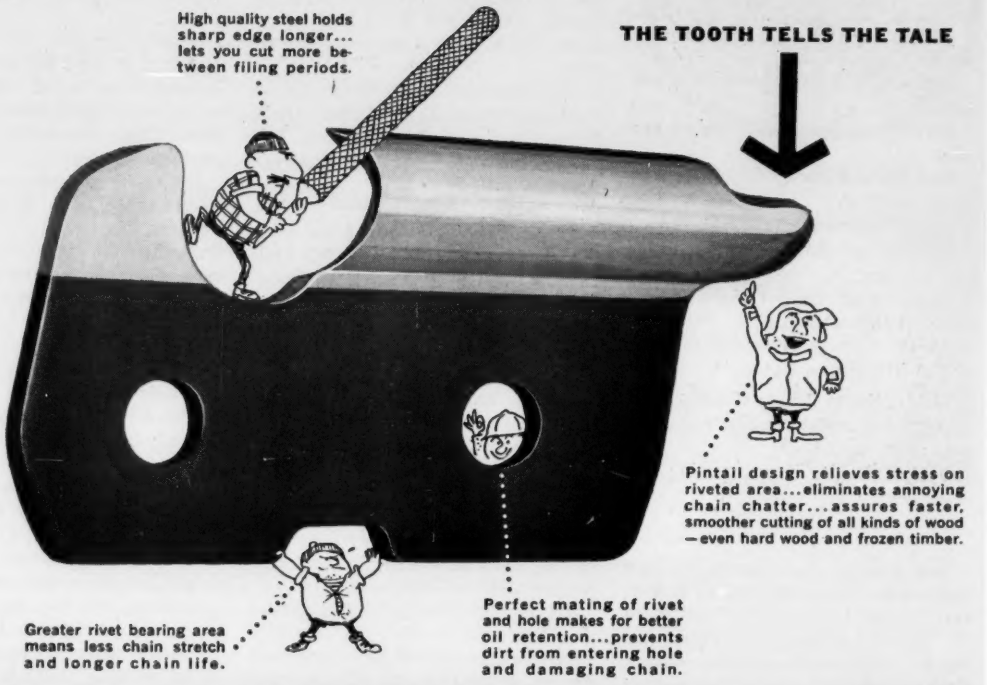
Opening General Session, morning.

Society Affairs Session; afternoon.

Division of Forest Products; evening.

Division of Watershed Management; evening.

FLOYD IVERSON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Tuesday, September 30

Division of Forest Management; morning and afternoon.

Division of Forest Recreation; evening.

Division of Forest Economics; evening.

Division of Forest-Wildlife Management; evening.

Wednesday, October 1

Division of Silviculture; morning and afternoon.

Division of Range Management; morning and afternoon.

Society Dinner; evening.

Thursday, October 2

Field Trip to Wassatch Watershed Management areas; morning and afternoon; men only.

Ladies' Scenic Tour; morning and afternoon.

Committees for the Meeting

The general co-chairmen for this meeting are Floyd Iverson, U. S. Forest Service, Ogden, Utah; and Reed W. Bailey, Intermountain Forest and Range Experiment Station, Ogden, Utah.

Chairman of the Program Committee is Lewis M. Turner, College of Forest, Range and Wildlife Management, Utah State University, Logan, Utah.

The chairman of the Committee on Arrangements is F. C. Koziol, U. S. Forest Service, Federal Building, Salt Lake City, Utah.

Hotel Reservations

Those expecting to attend the meeting are advised to arrive in Salt Lake City on Sunday, September 28, or not later than 9 a.m., on Monday, September 29. The first general session will start at 9:30 a.m., Monday, in the auditorium of the new Utah Hotel Motor Lodge convention center.

The Utah Hotel, facing Temple Square, will be the headquarters for the meeting. This hotel has 500 rooms, but it will not be able to accommodate all those in attendance, hence other hotels are making space available, including Utah Hotel's new Motor Lodge, also adjacent to Temple Square.

All requests for room reservations should be sent to the SAF Housing Committee, in care of the Convention Bureau of the Chamber of Commerce, P.O. Box 329, Salt Lake City 10, Utah. Second and third choices should be given.

Reservations will be accepted and confirmed in the order of their receipt. Assignment of rooms will be made at, or as near, the desired rate as possible. Early reservation requests are desirable.

The reservation coupon printed herewith may be used. However, readers who do not want to cut the coupon from their JOURNALS may request reservations by letter, provided all the information listed on the coupon is given.

Hotels

All rates quoted are with bath; these are daily rates.

Utah Hotel, South Temple and Main Streets; 500 rooms; garage attached. Single occupancy: $8, $9, $10, $11, $12, $13, $14. Double-bed rooms: $10, $11, $13, $14, $15, $16, $17. Twin-bed rooms: $11, $12, $13, $15, $16. Suites (sitting room, bedroom, and bath): single occupancy, $18 and up; double occupancy, $20 and up.

Utah Hotel Motor Lodge, West Temple Street facing Temple Square; 100 units; parking facilities. Single occupancy: $8 to $14. Double-bed rooms:

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Society of American Foresters

1958 ANNUAL MEETING

SALT LAKE CITY, UTAH SEPTEMBER 29 AND 30-OCTOBER 1 AND 2

Housing Committee, Society of American Foresters,
c/o Chamber of Commerce Convention Bureau,
P.O. Box 329,
Salt Lake City 10, Utah.

First choice hotel .....

Second choice hotel .....

Third choice hotel .....

Please make a reservation for the following room accommodations for arrival on September....., a.m. Departure ....., a.m.
p.m. p.m.

I understand that accommodations will be provided at the daily rate specified, if available; otherwise the next nearest rate will apply.

..... Single room with bath. Rate $.....

..... Double-bed room with bath. Rate $.....

..... Twin-bed room with bath. Rate $.....

..... Suite (parlor, twin-bed room, and bath). Rate $.....

..... Other. (Specify accommodations desired.) Rate $.....

The above accommodations are requested for the following persons in addition to myself. (Please print or typewrite names and addresses legibly.)

.....

.....

.....

My name: .....

Street address: .....

City, zone, state: .....

Important notice: Members submitting requests for hotel reservations are asked to check below whether they wish to go on the all-day field trip for men on Thursday, October 2. This trip is described elsewhere in the program of events. The number who can be accommodated is limited.

☐ I do ☐ I do not—wish to go on the field trip.

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$10 to $17. Twin-bed rooms: $12 to $17.

A rollaway bed may be brought in for an additional adult either at the Utah Hotel or Motor Lodge, the charge for which is $2 daily.

Temple Square Hotel, 75 West Temple and South Temple Streets, facing Temple Square; 188 rooms. Single occupancy: $5 to $7.50. Double-bed rooms: $7 to $9. Twin-bed rooms: $9 to $11. Rooms with three beds: $11 to $13.

Newhouse Hotel, Main at 4th South Streets; 400 rooms; adjacent garage; four blocks from Utah Hotel. Single occupancy: $6.50 to $9. Double-bed rooms: $8.50 to $12. Twin-bed rooms: $9 to $13. Suites: $20 to $32.

There are other hotels in Salt Lake City. The Convention Bureau will make reservations at hotels other than those listed above if members desire lower rates.

Motels and Motor Lodges

Salt Lake City has more than 30 motels. A complete list of them, together with their address and daily rates may be obtained on application to the Convention Bureau, P.O. Box 329, Salt Lake City 10, Utah.

In requesting a reservation at a motel, payment equal to the daily rate but in no case less than $6 should accompany the reservation request.

The following six motels are listed as they are less than six blocks from the Utah Hotel.

Brewster's Seagull Motel, 325 North 2nd Street West; $6.50 to $8.50.

City Center Motel, 134 West North Temple Street; $7.50 to $12.

Covered Wagon Motel, 230 West North Temple Street; $6 to $13.50.

Covey's New American Motel, 522 South Main Street; $6 to $12.

Deseret Inn Motor Hotel, 50 West 5th South Street; $8 to $18.

Western Motor Lodge, 323 West North Temple Street; $7 to $11.

Coming Events

Forestry, Conservation Communications Association

The Forestry, Conservation Communications Association will hold its ninth annual national conference July 16-18 at the Parker House, Boston, Mass.

Conservation Education Association

The CEA will hold its fifth annual conference at the University of Utah, Salt Lake City, August 18-21.

N. E. Tree Improvement Conference

The Northeast Tree Improvement Conference will be held at Beltsville, Md., August 21-22.

Society of American Foresters

The Hotel Utah, Salt Lake City, will be headquarters for the Society's 58th annual meeting scheduled for September 28-October 1.

Soil Conservation Society

City Auditorium, Asheville, N. C. will be headquarters for the 13th annual meeting of the Soil Conservation Society October 19-22.

American Forestry Association

The 83rd annual meeting of the American Forestry Association will be held in Tucson, Ariz., October 27-30, 1958. Headquarters will be the Pioneer Hotel. Meeting theme: "Water, Forests, and People."

Washington Section Officers Elected

Sixty-five members and guests attended the final dinner meeting of the 1957-1958 winter series of the Washington Section. Guest speaker was Richard Kilbourne, director of the Division of Forestry Relations, TVA, who described the forestry activities and accomplishments of his organization. TVA has just completed its first 25 years of development.

Results of the election of officers for the coming year were announced as follows:

Chairman—Kenneth B. Pomeroy, American Forestry Association.

Vice Chairman—Charles H. Stoddard, Resources for the Future, Inc.

Secretary—Earl J. Rodgers, U. S. Forest Service.

Treasurer—Thomas Glazebrook, U. S. Forest Service.

The office of treasurer is a new one for the Section, having previously been combined with that of secretary.

Corrections and Additions Section Officers Directory

The following corrections and additions should be made in the Section Officers Directory, published in the March JOURNAL OF FORESTRY, to bring it up to date, as of May 15, 1958.

Central Rocky Mountain: Add Black Hills Chapter.

Columbia River: Change Capitol Chapter to Capital; Coos Bay to Coos.

Gulf States: Add Mississippi and Texas Chapters.

Intermountain: Officers as of April 11, 1958: Paul A. Grossenbach, chairman, U. S. Forest Service, Ogden, Utah; Steele Barnett, vice chairman and membership chairman, Boise Cascade Corp., Box 200, Boise, Idaho; Richard W. Payne, secretary-treasurer, 1331 22nd St., Ogden, Utah.

Kentucky-Tennessee: Add Erwin G. Wiesehuegel, Box 196, Norris, Tenn., as vice chairman.

New England: Officers as of March 6, 1958. David M. Smith, chairman, School of Forestry, Yale University, New Haven, Conn.; Fred Holt, vice

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No. 44 Pole Saw is operated either from the ground or in the tree. It has a 16" blade with 7 peg teeth per inch or we can furnish special blades to suit operator's requirements.

Easily saws a 5 inch limb in a few seconds. Pole supplied in lengths 4 to 16 ft. one piece or sectional. Write for catalog on complete line of pruning equipment.

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Profitable crops like this

grow from site preparation like this!

Growing a profitable crop at the lowest possible cost is a matter of carefully planned forest site preparation. It calls for the choice of methods best suited to the operation. It also calls for the selection of equipment best suited for each particular job. To aid in the selection, Caterpillar has kept close tabs both on the use of different methods and equipment to evaluate their effectiveness. Some of the methods and machines used are shown here. Cost results on methods and machines have been compiled on the following subjects: Stump Treatment; Stump Clearing and Tree Cutting; Chaining; Raking and Windrowing; Harrowing; Planting. For information, write Logging Section, Caterpillar Tractor Co., or call your nearby Caterpillar Dealer. You'll find him listed in the Yellow Pages.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

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SHEARING AND STUMPING: Standing live oaks in a cleared area went down fast before this Cat D8 Tractor equipped with Rome K-G blade. Trees, 18" to 81" in diameter, were hit by the stinger at height of 3' to 4' above ground level, sliced and pushed over. Stump tops were sheared at ground level in one or several passes.

RAKING AND WINDROWING: Working in hammock lands with live oaks up to 72" in diameter, this D9 utilized a multi-application rake as a felling, raking and windrowing tool. Merchantable timber had been harvested, but no clearing completed. A D8, D7 and No. 977 Traxcavator with rakes handled the less dense areas.

HARROWING: After an area of hardwood, mixed pine and heavy brush had been chained, raked and stumps cut at ground level, this Cat D8 Tractor with heavy-duty harrow proved a most effective tool. The number of passes, one or two, on an operation like this, is up to the individual forest owner.

PLANTING: These two Caterpillar D4 Tractors equipped with V-plows and wild-land planters planted 20,000,000 seedlings on a 24,000-acre plantation. The sure-footed traction and dependable performance of these rugged Diesel Tractors contributed substantially to low-cost production on this operation.

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chairman and membership chairman, Maine Forest Service, Augusta; Bertram Husch, secretary-treasurer, Department of Forestry, University of New Hampshire, Durham.

New York: Officers as of March 27, 1958. Samuel R. Parmelee, chairman, Box 37, Tupper Lake, N.Y.; Stanley W. Hamilton, vice chairman, 89 Ludlow St., Saratoga Springs, N.Y.; Shelley W. Potter, Jr., secretary-treasurer, 5559 S. Salina St., Syracuse, N. Y.; and Neil J. Stout, membership chairman, State University of New York College of Forestry, Syracuse.

Ozark: Officers as of July 1, 1958. M. G. Hoyer, chairman, Forestry Division, Missouri Conservation Commission, Jefferson City; R. C. Smith, vice chairman and membership chairman, School of Forestry, University of Missouri, Columbia; and Harold S. Winger, secretary-treasurer, Rt. 7, Box 244, Pine Bluff, Ark.

Wisconsin-Michigan: Officers as of March 15, 1958: Donald G. Zettle, chairman, Department of Conservation, Marquette, Mich.; Harold A. Svensen, vice chairman and membership chairman, U. S. Forest Service, 623 N. 2nd St., Milwaukee 3, Wis.; and Donald Prielipp, secretary-treasurer, 724 Hamilton Ave., Kingsford, Mich., Chippewa Chapter.

James A. Egan (1912-1958)

James A. Egan, supervisor of the Deschutes National Forest, passed away at Bend, Ore., March 19, 1958. Leukemia, together with other complications, caused his untimely death.

Born September 7, 1912 in Benning, Calif., Mr. Egan received his B.S.F. degree from the University of California in 1935, his M.S.F. from the State University of New York in 1937, and his master's degree in public administration from American University, Washington, D. C. in 1942. He served as a Naval intelligence officer (photo interpretation) in the South Pacific during World War II and was awarded the bronze star for distinguished service.

JAMES A. EGAN

He started work with the U.S. Forest Service in 1935. The major portion of his career was in the southwest as district ranger, Coconino National Forest, range management staff, Cibola National Forest, and operations and timber management staff, Regional Office, Albuquerque, before becoming supervisor of the Deschutes National Forest in June 1956.

Mr. Egan was a staunch supporter of the Society of American Foresters. He was past chairman of the Southwestern Section and a contributor to the JOURNAL OF FORESTRY on ponderosa pine management in the Southwest and on administrative management at the grass roots.

James Egan's career, though short, was full and productive, marked by professional and administrative competence, vision, and a concern for the

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John S. Holmes (1868-1958)

John S. Holmes, first state forester of North Carolina, died May 2 in Raleigh, N. C., at the age of 89.

Mr. Holmes was born May 31, 1868 in Ontario, Canada. He came to the United States in 1881 and in 1905 graduated from Yale School of Forestry. He served as state forester in North Carolina from 1915 to 1945.

He was a Fellow of the Society of American Foresters and a charter member and past president of the Association of State Foresters.

people he worked with and served that drew all who knew him into a closer fellowship of common endeavor.

S. R. Gevorkiantz (1899-1958)

Suren R. Gevorkiantz, biometrician for the Lake States Forest Experiment Station, Forest Service, U.S. Department of Agriculture, died suddenly in St. Paul, Minn., on May 8.

Born July 27, 1899 in Tiflis, Russia, Mr. Gevorkiantz attended the Institute of Technology, Tomsk, Siberia in 1917-1918. He became a refugee in 1919 and spent three years in Manchuria, China, and Japan before coming to the United States. He obtained his forestry education at the University of California (B. S. 1924) and at Harvard (M. F. 1928).

Although widely known, his entire professional career was spent at the Lake States Forest Experiment Station where he specialized in forest mensuration and in the application of statistics to forestry problems. In the latter capacity he acted as a consultant to many private and public foresters and technicians in related fields.

Mr. Gevorkiantz's work has been reported in over 80 publications, of which he is the author or co-author, with emphasis on experimental design and various aspects of growth and yield. He was the joint author with the late J. W. Girard of a timber cruising manual widely used by timber estimators and teachers. He developed original yield tables for the principal forest types in the Lake States, composite volume tables that can be applied regardless of species, and devised a cumulative volume tally scheme widely used in many regions.

Mr. Gevorkiantz, a member of the SAF for 30 years, chairmanned the Minnesota (now Upper Mississippi Valley) Section of the SAF in 1941, and served as associate editor of the JOURNAL OF FORESTRY from 1946 to 1957, covering the field of forest mensuration. He was the recipient of the Superior Service Award of the U. S. Department of Agriculture in 1953, and was elected Fellow of the SAF in 1957.

H. R. Blanford (1884-1957)

Harry Richard Blanford, C.B.E., an Honorary Member of the Society of American Foresters, died at his home in Fleet, Hampshire, England, on December 19, 1957. He was born June 15, 1884.

He received his forestry education at the Royal Engineering College at Coopers Hill, and was appointed to the Burma Forest Service in 1905. On his retirement in 1926 he was chief conservator of forests. For his work there he received the Order of the British Empire. He was a world authority on teak.

From 1938 to 1952 he served as secretary of the Empire Forestry Association and was editor of *Empire Forestry* Review.

In 1951 on the occasion of the King's birthday honors he was promoted to Commander of the British Empire, an award made for exceptionally distinguished service.

He exerted a great and beneficial influence on the expansion of colonial forestry policy.

In 1952 the Council of the Society of American Foresters elected him an Honorary Member.

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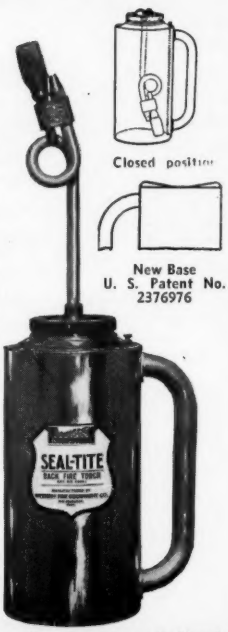

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H	100 U.S. GPM at 120 lbs.
2HB	200 U.S. GPM at 120 lbs.

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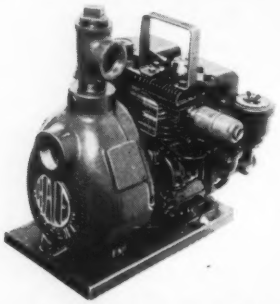

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Library Staff to Compile Index

With the cooperation of the State University College of Forestry at Syracuse University, Syracuse, N. Y., the Society plans to publish a ten-year cumulated Index of the JOURNAL OF FORESTRY for the years 1951-1960. This will be the fourth such index published.

Miss Martha Meelig, librarian at the College of Forestry, and her staff will compile the Index. Copies should be available early in 1961.

The first, second, and third cumulated indexes, covering publications during the life of the JOURNAL through December 1950, were compiled by the Appalachian Section of the Society.

Membership Applications and Advancements

Proposals for admission, advancement, and reinstatements received in the Society office during the month of May listed below.

Action on the eligibility of those proposed for membership as listed below will be taken by the Council as of August 1958.

Communications from the voting members regarding the membership eligibility of these persons should be received in the Society office prior to that date.

Allegheny Section

Student Grade

Arnold, E. W.
Contu, D. J.
Durdan, J. H.
Grahame, J. W.

Junior Grade

Students Eligible For Automatic Advancement

WEST VIRGINIA UNIVERSITY

Herman, R. J.
Obye, R. J.
Paxton, J. S.
Weaver, W. K.

Member Grade

Andresen, J. W., Instructor of Forestry, College of Agric., New Brunswick, N.J.; State Univ. of N.Y., B.S.F. 1953, (Junior 1953).

Appalachian Section

Student Grade

DUKE UNIVERSITY

Horton, D. W. (Reinstatment)
Utz, K. A.

Junior Grade

Adams, S. M., USFS, Franklin, N. C.; N.C. State, B.S.F., 1957.
Cross, W. J., Service Forester, Va. Div. of Forestry, Salem, Va.; Univ. of Mich., B.S.F., 1957.
Hinkle, J. C. Dist. Mgmt. Chief, Va. Div. of Forestry, Salem, Va. (Reinstatement).
Horton, D. W., Forester, S. C. Comm. of Forestry, Greenwood, S.C.; N.C. State, B.S.F., 1956. (Student 1954).
Lewis, T. D., Cons. Forester, Union Bag-Camp Paper Corp., Savannah, Ga. (Reinstatement).

Member Grade

Fishburne, H. B., Consulting Forester, Charleston, S.C. (Junior 1954).

Affiliate Grade

Nielsen, C. P., Woodland Manager, Owens-Illinois Glass Co., Big Island, Va.

Columbia River Section

Student Grade

OREGON STATE COLLEGE

Hoebel, W. G.
Nenand, J. E.

Junior Grade

Bjork, C. A., Forest Inspector, Ore. State Board of Forestry, Boring, Ore. (Reinstatement).
Claycomb, W. E. Range Cons., USDI, Warm Springs, Ore.; Iowa State, B.S.F., 1951.
Mace, J. C., Service Forester, Ore. State Board of Forestry, Medford, Ore.; Ore. State. B.S.F. 1942.
Thompson, R. L., Unit Forester, Bur. of Land Mgmt., Roseburg, Ore, (Reinstatement).

Member Grade

Seiser, V. O., Mgr., Bur. of Land Mgmt., Portland, Ore. (Junior 1951).

Gulf States Section

Junior Grade

Langhofer, W. A., Forester, Corps of Engs., Sardis, Miss. (Affiliate 1955).
Merrifield, R. G., Asst. Forester, La. State Univ., Homer, La.; La. State, M.F., 1958. (Affiliate 1955).

Member Grade

Ewing, E. R., Pulpwood Dealer, Pineville, La.; L.P.I., B.S.F., 1950. (Junior 1954).
Hoag, C. A., Unit Forester, Int'l Paper Co., Jefferson, Texas. (Junior 1951).
Viele, D. H., Field Asst., Int'l Paper Co., Zwolle, La. (Junior 1951).

Affiliate Grade

Dorris, P. C., Forestry Aid, USFS, Holly Springs, Miss.
Hannaford, W. A., Area Forester, Miss. Forestry Comm., Oxford, Miss.
Harrelson, R. M., Forest Tech., Int'l Paper Co., Brandon, Miss.
Harty, E. W., Asst. Forester, Texas Forest Service, Lufkin, Texas.
Rogers, F. M., Mgr. & Part Owner, Rogers Hereford & Tbr. Farms, Porterville, Miss.

Inland Empire Section

Student Grade

UNIVERSITY OF IDAHO

Ferguson, R. M.

Intermountain Section

Junior Grade

Strang, J. S., Dist. Forest Ranger, USFS, Circleville, Utah. (Reinstatement).

New England Section

Student Grade

YALE UNIVERSITY

Funsch, R. W.

Junior Grade

Heitmann, A. F., Ass't of Forest Mgmt., Montpelier, Vt. (Affiliate 1954).

Lutz, E. E., Forester, USFS, Norway, Maine; Pa. State, B.S.F., 1957.

Northern California Section

Junior Grade

Brinkeroff, D. W., Resident Forester, Hearst Wyntoon Tree Farm, McCloud, Calif.; Ore. State, B.S.F., 1952.

Northern Rocky Mountain Section

Student Grade

MONTANA STATE UNIVERSITY

Tribe, C. B.

Ozark Section

Junior Grade

Gould, L. K., Forester, Int'l Paper Co., Sheridan, Ark.; Colo. State, B.S.F., 1956.

Hale, D. A., Unit Forester, Int'l Paper Co., Rison, Ark. (Affiliate 1954).

Morrison, J. B., Mgmt. Unit Forester, Int'l Paper Co., Malvern, Ark. (Affiliate 1956).

Peace, B. O., Unit Forester, Int'l Paper Co., Rison, Ark. (Affiliate 1955).

Sanders, W. F., Mgmt. Unit Forester, Int'l Paper Co., Malvern, Ark. (Affiliate 1955).

Affiliate Grade

Martin, G. E., Forester, Heber Ranger Station, Overgaard, Ariz.

Puget Sound Section

Student Grade

UNIVERSITY OF WASHINGTON

Bowman, R. M.

Junior Grade

Buhaly, J., Co. Ext. Forester, State College of Wash., Pullman, Wash. (Affiliate 1952).

Member Grade

Hall, J. L., USFS, Asst. Supv., Juneau, Alaska. (Junior 1951).

Harrison, S., Forester, USFS, Ketchikan, Alaska. (Junior 1951).

Laurent, T. H., Forester, Alaska Research Center, Douglas, Alaska. (Junior 1951).

Smith, R. A., Forestry & Range Officer, Bur. of Land Mgmt., Fairbanks, Alaska. (Junior 1951).

Vogel, D., Tract Forester, Lantzville, B.C., Canada. (Junior 1951).

Affiliate Grade

Cook, R. A., Dist. Asst., Verlot Ranger Station, Granite Falls, Wash.

Undi, N. J., Forest Mgmt. Asst., USFS, Beaver, Wash.

Associate Grade

Whaley, C. R., Logging Supt., Peshastian Lbr. & Box, Inc., Peshastian, Wash.

Southeastern Section

Student Grade

Bruni, R. L. (Reinstatement).

Junior Grade

Bruni, R. L., U. S. Navy, Pensacola, Fla.; Univ. of Calif., B.S.F., 1957. (Student 1955).

Kornegay, R. C., Farm Forester at Large, Florida Forest Serv., Lakeland, Fla.; N.C. State, B.S.F., 1950.

Member Grade

Zimmerman, J. D., Staff Asst., Union Bag-Camp Paper Corp., Savannah, Ga.; Duke, M.F., 1954. (Junior 1954).

Upper Mississippi Valley Section

Student Grade

IOWA STATE COLLEGE

Houtchens, F. L. Volkman, D.

UNIVERSITY OF MINNESOTA

Glowacki, W. E.

Junior Grade

Pulkrabek, L. J., Forester, USFS, Maurice J. Salisbury Co., Inc., Grand Rapids, Minn. (Reinstatement).

Student Eligible for Automatic Advancement

UNIVERSITY OF MINNESOTA

Reidel, C. H.

Affiliate Grade

Ward, A. J., Area Forester, Minn. Forest Service, Blackduck, Minn.

Wisconsin-Michigan Section

Student Grade

MICHIGAN STATE UNIVERSITY

Bright, J. N. Hansen, H. T.

Eising, P. L. Kasmierczak, R. V.

UNIVERSITY OF MICHIGAN

Harper, S. C.

Junior Grade

Wolfe, R. M., Asst. Dist. Forester, Au Sable State Forest, Grayling. Mich.; Mich. M. & T., B.S.F., 1954.

Member Grade

Wilson, R. M., Supv., Soil Cons. Serv., Pontiac, Mich. (Junior 1951).

Affiliate Grade

Hemingway, B. R., Asst. Dist. Forester, Kimberly-Clark of Mich., Inc., Munising, Mich.

No Section

Corresponding Grade

Arvanitis, L. G., Forester, Ministry of Agric., Athens, Greece; Univ. of Salonica, General Forestry - Diploma, 1953.

Bayoglu, S., Assistant, Univ. of Istanbul, Istanbul, Turkey, Univ. of Istanbul, B.S. (Forest Eng.) 1951.

Gutierrez, M., Colombia, South America; Universidad Nacional, Facultad de Agronomia e Instituto Forestal; Forestry, Ing. Forestal., 1956.

Shou-wei, S., Dir. of Alishan Logging Station, Taiwan Province, Taichung Taichung, Taiwan; Peking Univ., M. A. Forestry, 1932.

Yang, B. Y., Jr. Specialist, Taiwan Forest Research Institute, Taiwan, Formosa; Northwestern College of Agric., B.S. (Silviculture), 1946.

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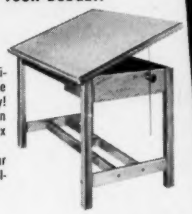

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Forestry News

White House Conservation Ceremony Commemorates Roosevelt Centennial Year

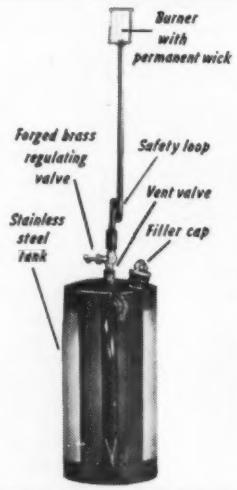
In observance this year of the 100th anniversary of the birth of President Theodore Roosevelt, President Eisenhower and several members of his staff presided at a conservation program held in the Rose Garden of the White House in May 8.

President Eisenhower announced two outstanding achievements in conservation for the past year—the fewest forest fires and the most trees ever planted. In token of the alltime low forest fire record in 1957, the President presented special awards—gold Smokey Bear statuettes—to heads of three organizations for "outstanding public service in forest fire prevention." He also presented one of the golden Smokeys to 12-year-old Judy Bell, Santa Fe, N. Mex., in recognition of the "fine cooperation the children of America have given forest fire prevention." It was in 1950 when the then 4-year-old Judy nursed Smokey, a badly burned little brown bear cub, to health after he was rescued from a forest fire on the Lincoln National Forest near Capitan, N. Mex., U. S. Forest Service Chief McArdle introduced Judy to the President.

PRESIDENT EISENHOWER plants an oak tree on White House lawn at ceremonies commemorating the anniversary year of the birth of Theodore Roosevelt, pioneer leader in the conservation movement in the United States.

The other statuettes were presented by the President after members of the Cabinet and Sherman Adams, special assistant to the President, made appropriate statements. One was given to John Sterling, chairman of the board of The Advertising Council, Inc., and publisher of *This Week* magazine. Secretary of Agriculture Benson cited the Council's "great contribution in planning the Smokey Bear campaign since it began in 1942."

John B. Veach, Sr., president of American Forest Products Industries, Inc., received one after Interior Secretary Fred A. Seaton recognized AFPI's



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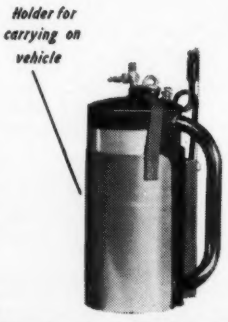

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GIVEN Golden Smokey Bear statuettes for public service in forest fire prevention at a White House ceremony were: (L to R) Don P. Johnson, American Forestry Association; Judy Bell, in recognition of the "fine cooperation of the children of America"; John Vech, American Forest Products Industries, Inc.; and John Sterling, The Advertising Council, Inc.

"fire prevention efforts through the Keep America Green program and other activities."

The other Smokey was presented to Don P. Johnston, president of the American Forestry Association. Sherman Adams noted that organization's "continuing educational work in forest fire prevention."

President Eisenhower noted that tree planting in the nation reached 1 billion in 1957, the first time in history this many seedlings had been placed in the ground in one year. Most of this planting was on privately owned land. Commemorating this encouraging trend in reforestation, which coincided with the Roosevelt Centennial year, the President planted on the White House grounds a 22-foot scarlet oak.

Attending the ceremony, in addition to members of the President's Cabinet and staff, were representatives of the Departments of Agriculture and Interior, and conservationists in Washington for the annual Cooperative Forest Fire Prevention planning meeting.

Forest Fires Nationwide Hit All-Time Low

Forest fires were held to a record low of 83,400 nationwide in 1957, breaking the 100,000 mark for the first time, according to the U. S. Department of Agriculture.

The statistics compiled by the U. S. Forest Service are based on reports from its field offices, state foresters, the Department of the Interior, and the Tennessee Valley Authority.

Last year's record compares with 143,000 forest fires in 1956 and 200,800 ten years ago in 1947. The area burned was almost halved, dropping from 6,605,900 acres in 1956 to 3,409,000 in 1957. Ten years ago fires burned 23,225,932 acres.

The Department of Agriculture gives much credit for the 1957 record to the American public. It commended three programs for outstanding con-

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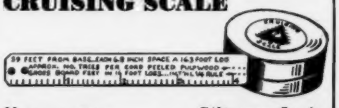
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tributions to forest fire prevention: (1) the Smokey Bear Campaign sponsored by its Forest Service and the state foresters under the leadership of the Advertising Council; (2) the Keep Green Programs conducted by forest industries and the states; (3) the work of the American Forestry Association in spearheading the Southern Forest Fire Conference in New Orleans two years ago. The greatest reduction in the number of forest fires occurred in the South where 44,100 were reported in 1957 as compared to 102,700 in 1956. While weather conditions were favorable to low fire records generally, the fire fighting agencies believe that the Fire Prevention Conference of 1956 contributed greatly to the reductions. At the conference representatives of law enforcement agencies, women's clubs, industries, state conservation agencies, and other leading individuals discussed mutual problems and possible solutions.

Law enforcement efforts adopted after the Conference caused incendiary fires in the South to drop from 20,800 in 1956 to 11,700 in 1957. States and even counties have held their own forest fire prevention conferences and have come up with active prevention programs which they publicized locally. As a further effort, the Southeastern Fire Compact was activated last fall whereby the ten states from Virginia and Kentucky, south, and east of the Mississippi River, can exchange men and equipment in case of emergencies, thus strengthening control programs.

There were, however, several hot spots around the country last year. New England and New York last May had to close the woods because fires were so numerous. The fire record for the year in the eastern region, Maine through Kentucky, showed an increase in the number of fires from 15,000 in 1956 to 19,400 in 1957.

In some states acreages burned increased two to seven times. In Idaho, for instance, 1,252 fires in 1956 burned 18,995 acres, while last year 1,327 fires burned 135,899 acres. Some 3,430 fires in North Carolina burned 93,691 acres in 1956 compared with 2,618 fires burning 164,916 acres in 1957.

Alaska, not included in the totals above, had one of its worst years with 264 fires burning 4,718,372 acres.

The three major causes of forest fires during the past few years have been incendiarists, debris burners, and smokers. In 1956 incendiarists topped the list; in 1957 debris burners were

No. 1, starting 16,181 forest fires on lands given organized protection.

Conference on Use of Chemicals in Fire Control Held

The use of chemicals in the suppression of forest, brush, and grass fires was demonstrated at the Midwest Conference on Fire Control with Chemicals in Forest Areas, held May 12 and 13 at Baraga, Mich.

Water suspensions of sodium calcium borate were used in suppression of fires in several fuel types at the conference, sponsored by the Forestry Department of Michigan College of Mining and Technology, Houghton, Mich., through its Institute of Extension Services. Both ground and aerial control of fires were demonstrated. Latest mixing, pumping, and transporting equipment, and air-drops from three types of airplanes, were shown.

Climax of the conference was a 30-acre running crown fire in dense jack pine timber, in which both mechanical and chemical control methods were utilized.

A total of 240 persons attended the conference, representing several sections of the United States and Canada. This was the first use of sodium calcium borate in fire suppression in this part of the United States and Canada.

Results indicated that the borate imparts a very effective flame resistant coating on light fuels and greatly reduces the combustion of heavier fuels when applied ahead of the flames. It appeared particularly useful as a means of quickly preparing a line for backfiring purposes, stopping grass fires, and preventing the lateral or windward spread of forest fires. Air-drops of the chemical seemed especially well suited to fire control in inaccessible areas. When used as a protective coating from adjacent burning it was found highly effective to such conditions.

Conservation Reserve Totals 4,000,000 Acres

Over 4,000,000 acres of cropland were offered for contracts under the 1958 Conservation Reserve of the Soil Bank through the close of the sign-up period on April 15, according to preliminary figures compiled by the U.S. Department of Agriculture from State ASC committees.

The 4,000,000 acres offered are covered in 64,572 applications for 1958 contracts and are in addition to 6,500,000 acres put in the program by 89,266 farmers in 1956 and 1957.

Under the Conservation Reserve, farmers sign contracts to divert general cropland from production into soil and water conservation uses, tree plantings and wildlife habitat for periods of 3, 5, or 10 years.

Alabama Registration Board Completes Organization

R. V. Miles, Tuscaloosa, vice-chairman of the Alabama State Board of Registration for Foresters, was named chairman of the rules and regulations committee at a recent meeting of the Board in Montgomery.

John C. Mitchell, Florence, was named chairman of the examination committee.

Mr. Miles is manager of the forestry division, Gulf States Paper Corporation, Tuscaloosa and Mr. Mitchell is forestry representative, Division of Forestry Relations, TVA, Florence.

Organization of the five-man board is now complete and all licensing documents have been approved. Information on licensing as provided in Act 533, is now available from the board's headquarters, 711 High St., Montgomery, Ala.

Chairman of the board is W. B. DeVall, forestry department head, API Agricultural Experiment Station.

Northeastern Loggers Hold Fourth Congress

More than 300 loggers, lumbermen, foresters, and equipment suppliers met at the Mark Twain Hotel, Elmira, N. Y., April 20 - 23 for the Fourth Northeastern Loggers' Congress and annual meeting of the association.

The Congress included four discussion sessions: "New Methods and Machinery," "Logging and Forest Management on Small Lots," "Logging Safety," and "The Sawmill Clinic"; a banquet with Abbott Fox of the Fox Lumber Co., Iron Mountain, Mich., as the principal speaker; and visits to nearby logging operations and wood-using industries.

Fred C. Simmons of the Northeastern Forest Experiment Station, Up-

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per Darby, Pa., was general program chairman.

The Association voted to extend its territory, which previously covered the 12 states from Maine to West Virginia, into five additional states: Ohio, Illinois, Indiana, Michigan, and Wisconsin.

Research Symposium To Be Held in Montreal

"Properties of Hardwoods and their Relation to Pulp and Paper Manufacture" is the title of the Third International Fundamental Research Symposium to take place on September 15-17 at the Queen Elizabeth Hotel, Montreal, Quebec. The symposium is being jointly sponsored by Technical Association of the Pulp and Paper Industry and the Technical Section, Canadian Pulp and Paper Association.

Requests for reservations should be addressed to A. H. Goodier, Jr., Queen Elizabeth Hotel, Montreal.

Allied

AFA Plans Minnesota Land Study

Plans are underway for the American Forestry Association to study land ownership in Minnesota. Samuel T. Dana, dean emeritus, School of Natural Resources, University of Michigan, will direct the study.

The project was made possible by a $25,000 grant from the Louis W. and Maud Hill Family Foundation.

A similar study was recently completed for California.

Langdale Heads Forest Farmers Association

Harley Langdale, Jr. of Valdosta, Ga. was elected president of the Forest Farmers Association, a 15-state organization of individuals and companies owning 25 million acres of southern timberland, during the group's recent board meeting in Monroe, La. He succeeds J. V. Whitfield of Wallace, N. C., who has served since 1952.

Langdale is a professional forester and president of The Langdale Company, which has widely diversified timber growing and processing interests in South Georgia. The company was founded in 1894.

Mr. Langdale has been prominent in national and regional, as well as local, forestry activities and his company was a charter member of the Forest Farmers Association. On the national level, he serves as one of the South's representatives on the National Forest Research Advisory Committee. He took his professional training at the University of Georgia.

The Langdale Company has been active in the American Turpentine Farmers Association, and his father, Judge Harley Langdale, Sr., is currently president of that organization. Former president J. V. Whitfield was elected a permanent member of the board of directors, after heading the Forest Farmers Association during six of its most successful years.

John W. Squires, forestry manager, Mississippi Products, Inc., Jackson, Miss. was re-elected vice president; and all of the regional vice presidents were re-elected. These include: W. S. Beasley, Columbia, Tenn.; Frederick H. Dierks, Kansas City, Mo.; Walter J. Damtoft, Canton, N. C.; Earl Porter, Mobile, Ala.; and Travis MacClendon, West Monroe, La.

Walter Myers was re-elected executive director of the Association, which has its headquarters in Atlanta, Ga.

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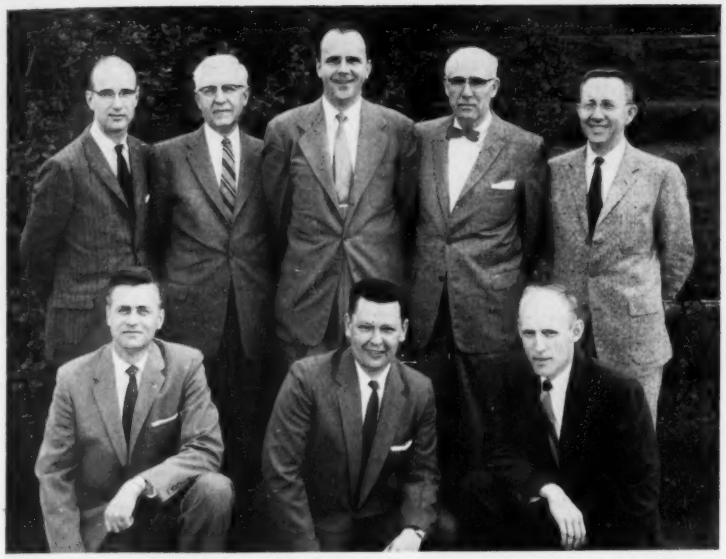

UNIVERSITY OF ILLINOIS FORESTRY FACULTY. Top row, l. to r.: Charles S. Walters, professor; J. Nelson Spaeth, head of Department and professor; J. J. Jokela, research associate; Ralph W. Lorenz, professor; W. R. Boggess, professor.
Bottom row: John K. Guiher, assistant professor; Kenneth R. Peterson, assistant professor; Charles E. Olson, Jr., research associate.
Not in photograph: Robert G. Rennels, assistant professor.

John H. Hinman, chairman of the board of International Paper Co., received the Forest Farmer Award for "his outstanding contributions to the advancement of forestry endeavor and full forest development in the South and throughout the nation."

More than 225 delegates from throughout the South attended the 2-day conference March 27-28 at Monroe, La.

Education

Michigan State Hosts 1958 Midwest Forester's Conclave

Michigan State University's Forestry Club sponsored the fifth annual Midwest Forester's Conclave at Proud Lake Recreation Area near Milford, Mich., May 2-4.

Iowa State College, Purdue, University of Michigan, University of Minnesota, and Michigan State sent representatives. Strict rules governed competition in events which included dendrology, compass and traverse, chopping, rail splitting, log rolling, two-man bucking, chain throwing, log throwing, match splitting, archery, and tobacco spitting. Judges were F. Dean Freeland, R. Keith Hudson, and Jonathan Wright of Michigan State University staff and John Carow of the University of Michigan. The Purdue University Forestry Club took first place for the fourth consecutive year in the "old-time logging" competition.

Lester E. Bell, Michigan State extension forester, reported on his forestry tour under the European Technical Assistance Program in West Germany.

Robert Goodman of the Michigan State Forestry Club was general chairman of the conclave.

Two Forestry Curriculums at University of Illinois Announced

Effective in June, the University of Illinois at Urbana offers two four-year undergraduate curriculums leading to the degree of Bachelor of Science in Forestry. They are forest production and wood technology and utilization.

Junior courses in the professional curriculums will be offered during the fall term of 1958, and senior courses in 1959-1960. The first degree will be awarded in 1960.

According to J. Nelson Spaeth, head of the Department of Forestry, students from other institutions who have the essential equivalent of the pre-forestry curriculum previously offered at the University were to be accepted for the 1958 summer camp.

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A. D. Nutting New Director of Maine School of Forestry

Albert D. Nutting, Forest Commissioner for Maine, has been appointed director of the School of Forestry in the College of Agriculture at the University of Maine, Orono, and head of the Department of Forestry in the Maine Agricultural Experiment Station, effective July 1, 1958. A native of the State, he was graduated in forestry at the University in 1927.

ALBERT D. NUTTING

Mr. Nutting's experiences include work with private industry, 17 years as forestry specialist with the Maine Extension Service, and ten years as Forest Commissioner for Maine. He brings to his new responsibilities general professional and industrial recognition for his substantial contributions to national forestry programs in general and to northeastern forestry in particular.

Director Nutting is a Member of the Society of American Foresters, past president of the Association of State Foresters, vice chairman of the Northeastern Forest Experiment Station Advisory Committee, member of Northeastern Forest Tree Committee, and a member of the State Park Commission.

In his new capacity at the University of Maine, Director Nutting will be responsible administratively for the undergraduate and graduate programs and for the research work in forestry and wildlife management.

Private & Industrial

Forrest Named Rayonier Inc. Timber Chief in Northwest

L. J. Forrest was named manager of Rayonier's Northwest Timber Division in May succeeding M. B. Houston, who is nearing retirement, according to an announcement by James T. Sheehy, executive vice president.

Mr. Houston entered the pulp and paper business in 1912 and joined the chemical cellulose and wood pulp producer as a purchasing agent in 1930. He has been associated with the company continuously since then. He will continue with Rayonier at its Seattle offices as a special representative.

Forrest began his career in forestry with the Polson Logging Company in 1932 while still a student at Washington State College. Early in 1956 he became assistant manager of Rayonier's Northwest Timber Division.

AFPI Appoints New York Representative

American Forest Products Industries has announced the appointment of Armand Rotonda of Morristown, N. J., as district manager of its New York office.

Rotonda, former Newark, N. J., newspaperman, will direct AFPI's programs of forestry education and public relations in New York City and throughout the state.

Southern Bell to Sponsor 4-H Program in North Carolina

North Carolina's 4-H Forestry Awards and Camp Program will again be sponsored in 1958 by the Southern Bell Telephone and Telegraph Company, in cooperation with the Agricultural Extension Service.

As sponsor, Southern Bell will finance the annual 4-H forestry camp, to which each county is invited to send one delegate; silver medals to county best-record winners; a trip to 4-H club congress for the state's best-record winner; and trips to state 4-H club week for district demonstration winners and awards for the state demonstration winner.

Continental Can Company Scholarships Awarded

A. L. Wenrich, district woodlands manager for Continental Can Company, Inc., Hopewell, Va., recently announced the award of the 1958 Continental Can Company Forestry Scholarships to William L. Reynolds of Spout Spring, Va. and Frank M. Morrison of Maxton, N. C., both high school seniors. The scholarships are for $1,000 per year for four years of study in the field of forestry.

Selections are made in Virginia and North Carolina by committees composed of Dr. W. C. Percival, head, Division of Forestry at West Virginia University; George Dean, state forester, Virginia Division of Forestry;

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Carl Holcomb, extension forester of Virginia; Dr. R. J. Preston, dean, School of Forestry, North Carolina State College; F. H. Claridge, state forester, North Carolina Department of Conservation and Development, Walter Keller, North Carolina forestry extension specialist, and Mr. Wenrich.

St. Regis Awards Scholarship in Northwest

St. Regis Paper Company announces the award of its undergraduate scholarship in forestry in the Northwest United States for the academic year 1958-59 to George Quinn, Jr., of Trenton, N. J., attending Montana State University, Missoula.

Quinn was chosen by a committee consisting of J. Herbert Stone, regional forester, U. S. Forest Service, Portland, Ore.; Robert W. Cowlin, director, Pacific Northwest Forest and Range Experiment Station; E. G. Griggs, II, president of St. Paul and Tacoma Lumber Company, subsidiary of St. Regis Paper Company; and Paul M. Dunn, technical director of forestry, St. Regis.

Trees for Tomorrow Re-elects Officers

For the 15th consecutive year the following officers of Wisconsin's Trees for Tomorrow Inc. were elected by members of the board at their annual meeting held at Merrill recently.

Folke Becker, board chairman Rhinelander Paper Co.—president; E. B. Hurst, woodlands manager Consolidated Water Power & Paper Co.—vice president; C. J. McLaren, vice president Owens-Illinois Tomahawk Mill Division—vice president; D. B. Smith, president Wausau Paper Mills Co.—secretary and treasurer; M. N. Taylor, executive director. Sponsors are 13 Wisconsin paper mills and five power companies.

Executive Director Taylor reported that since 1944 Trees for Tomorrow has distributed and machine planted 15 million trees for 7,570 people while forest management plans have been prepared for 783 landowners covering 206,358 acres of privately owned woodlands. In its program of conservation education Taylor said that by the close of the current season more than 32,000 people will have studied at the Trees for Tomorrow Camp, Eagle River. Of this number 10,000 are students from 51 percent of Wisconsin high schools.

P. O. Donaldson Joins Greenacres

Perry O. Donaldson, Jr., recently joined the staff of Greenacres, Inc., consultants, Seattle, Wash. He is presently managing a project in the Philippines.

Since receiving his B.S.F. degree in 1936 from the University of Washington, Mr. Donaldson has worked in both public and private forestry. From 1950 to 1956 he was employed as a forest management engineer by the Basilan Lumber Company, Philippines.

Colburn Receives KMG Award

Floyd Colburn, Itasca County, Minnesota extension forestry agent, has received a senior forestry award from Keep Minnesota Green, Inc.

The award was made at the annual meeting of KMG in Minneapolis April 30. Also receiving the award were George A. Selke, Minnesota Commissioner of Conservation, Robert R. Power, Backus, manager of the KMG emergency radio network and the Pine County KMG committee.

The award is made to individuals and groups who have made outstanding contributions to forestry work in Minnesota.

Colburn was one of the first extention forestry agents in the nation. He is a 1933 forestry graduate from the University of Minnesota and was employed by the Lake States Forest Experiment Station and the U. S. Forest Service and served in the U. S. Army before taking the Itasca County position in 1946.

Public

W. S. Rosecrans Honored

William S. Rosecrans, who resigned on January 15, 1958, from the California State Board of Forestry, was feted at a dinner in his honor at the Fairmont Hotel in San Francisco on April 10. Mr. Rosecrans was chairman of the California State Board of Forestry 14 years, having been appointed on January 10, 1944. During his tenure of service to the State of California, he is credited with a major role in planning and achieving the enactment of the Forest Practice Act, State Forest Purchase Act, and range improvement legislation, for the improvement of forest, watershed, and range lands, and the development of a long-range research program for

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Index to Advertisers

	Page
Adirondack Forestry, Inc.	539
Atkinson, S. Gayley	540
Banzhaf, George & Co.	541
Bartlett Mfg. Co.	530
Belanger & Bourget	540
Bozett, Wm. J.	539
Caterpillar Tractor Co.	531
Clifton, Thomas C.	539
Coile, T. S.	538
Crank, Porcius F. Jr.	540
Cranston, Keith	538
Eastman, Wm. A. Jr.	541
Fechheimer Bros. Co.	542
Forestry Suppliers	528
Greenacres, Inc.	538, 540
Guthrie, John G.	539
Hale Fire Pump Co.	534
Hall, Albert G.	540
Hall, Jack M.	541
Hammon, Jensen & Wallen	538
Haynes Mfg. Co.	532
Homelite Corporation	4th Cover
International Harvester Co.	3rd Cover
Keene Forestry Assn.	542
Knoth, Robert F.	539
Kurfew, Inc.	537
Lemieux, Frank J.	541
Lind, A. L. Co.	537
Lowther, Harry A. Co.	529
McCulloch Motors Corporation	527
Meadows, Ben	533
Musser Forests, Inc.	542
National Agricultural Supply Co.	530
Nelson Co.	529
Northern Tree Co.	540
Pacific Weather Service	535
Panama Pump Co.	536
Pomeroy & McGowin	541
Pond & Moyer Co., Inc.	540
Prentiss & Carlisle, Inc.	539
Price, Wm. H.	541
Rich, C. H. Forest Fire Tool Co.	537
Rootspred Tree Planter	532
Sanders, Paul M.	541
Sandvik Steel, Inc.	528
Sebrell, J. B. Corp.	537
Sewall, James W. Co.	538
Silva, Inc.	535
Smith, D. B. Co.	2nd Cover
Southern Seed Co.	542
Stock, John W.	539
Stratex Instrument Co.	535
Timber Mgmt. Service	540
Tree Farm Mgmt. Service	539
Utility Tool & Body Co.	535
Western Fire Equipment Co.	533
Weyerhauser Timber Co.	466
Winslow, Paul T.	539

improving the management, protection, and utilization of California's wildlife resources.

Those in attendance at the dinner in his honor included present as well as former members of the Board of Forestry and their wives, representatives from the timber, livestock, and allied industries and their wives, cooperating conservation agencies, federal, state, county, local government, and Chambers of Commerce.

Gee Heads Wildlife Management Section

Merle A. Gee, formerly supervisor of the Fish Lake National Forest in Utah, has succeeded Fred W. Johnson as head of the Wildlife Management Section, Division of Grazing and Wildlife, Forest Service, Missoula, Mont. Mr. Johnson retired from the post May 31 after 40 years of government service.

Mr. Gee recently completed a long assignment in the national headquarters of the Forest Service in wildlife work.

Research Council Has Tenth Annual Meeting

The tenth annual meeting of the Lower Peninsula Forest Research Council was held April 18 at Manistee National Forest, Wellston, Mich. The Council, organized in 1949 by the Lake States Forest Experiment Station, coordinates and promotes research at the Experiment Station, University of Michigan, Michigan State University, and others.

Mr. M. B. Dickerman, director, Lake States Forest Experiment Station, was elected chairman for the coming year. He succeeds Russell O'Neil, chief forester, Consumers Power Company. John L. Arend, leader of the Lower Peninsula Forest Research Center, serves as permanent secretary of the group.

Proceedings of each meeting are on file at the U.S. Department of Agriculture Library, Washington, D.C.

Willamette Forester Transfers

Transfer of Fremont McComb from the Willamette National Forest headquarters at Eugene, Ore., to a staff position in the division of timber management in the Pacific Northwest Region of the U.S. Forest Service has been announced by Regional Forester J. Herbert Stone.

McComb will work in the section of Management Plans and Sales Administration. The move became effective May 4. Since June 1955 McComb has been a staff officer on the Willamette National Forest in charge of land use, rights of way, and recreation.

Forestry Employment

S.A.F. members are privileged to insert one 60-word advertisement in this column without charge. Forest industries desiring to employ foresters may insert advertisements at the rate of $4 per column inch. Copy must be received by the end of this month for an advertisement to appear in the issue after next.

Obviously, the Society cannot assume responsibility beyond making it possible for prospective employee and employer to enter into negotiations.

Positions Wanted

Forester, B.S., University of Washington, 1949. Age 35, married, 3 children. Experience in tropical forest engineering and management. Desires employment with a progressive company in the tropics, or with a consulting firm doing work in tropical forests. Detailed summary of experience and qualifications furnished upon request.
Box T, Journal of Forestry, Mills Building, Washington 6, D C.

Graduate forester (Mass. 1954; Yale 1955), single, 26 years old. Three years duty with Coast Guard. Desires association with private enterprise, preferably in the Northeast. Professional experience limited to summer and part-time work, but willing to invest liberal time with progressive organization.
Box U, Journal of Forestry, Mills Building, Washington 6, D. C.

Forester B.S.F., 1951, Purdue Univ. Age 33, Veteran, married, one child. 3 yrs. U.S.A.F., 1 year state forestry. 6 years industrial production, supervision, and management. Desire position in forest management and/or planting or position related to forestry. North central states preferred, but other regions considered.
Box V, Journal of Forestry, Mills Building, Washington 6, D. C.

Graduate forester, B.S.F., University of Mich. 1950, age 33, married, 2 children. Experience: Consultant work including forest land management, timber appraisals, timber marking, timber scaling, planting and reforestation, timber sales, and a registered land surveyor. Desire position with progressive private firm. Prefer Lake States region or Southeast.
Box W, Journal of Forestry, Mills Building, Washington 6, D. C.

Nurseryman—Graduate forester, B.S.F., 1932. Age 49, in good health. 15 years experience as nurseryman of 20 million capacity nursery, 9 years of varied forestry experience. Prefer Southeast or South.
Box X, Journal of Forestry, Mills Building, Washington 6, D. C.

Forester, B.S.F., Michigan State Univ. Age 46, married, 5 children. Experience: 4½ years developing and managing 32,000-acres with annual timber sales of 3½ million feet. 11 years as manager of bobbin and sawmill plant, including timber management, logging and procurement; supervised 40 employees. Desire position in forest management and/or mill management. Willing to relocate.
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